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The British textile industry is world famous, and in this practical survey of its activities, Mrs Lovat Fraser has put into a convenient form a great deal of technical information. She describes the historical background of the industry; how regional developments arose, how certain localities became famous for some special material or branch of skill Raw materials and manufacturing processes are fully examined and their ramifications explained. Everything is covered, dress materials, furnishing fabrics, ribbons and the various fibres from which these are made. The book is abundantly and choicely illustrated, an informative glossary is included, and there is a section on the work of designers engaged in the industry

Mrs Lovat Fraser has made this book an essential tool for all who are engaged in or interested in the textile trade, at home or abroad Manufacturers, wholesalers, retailers, sales executives, designers, students, and everyone concerned with the making, handling, or use of textiles will welcome a book of reference which saves their time and reveals the extent, the creative genius, and the progressive ideas of a great British industry

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TEXTILES BY BRITAIN

TEXTILES BY BRITAIN

Grace Lovat Fraser

LONDON

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AUTHOR'S NOTE

THOUGH THE WORD textiles technically means all materials made from fibres: dress and furnishing cloths, carpets, lace and knitwear, as well as a large range of industrial cloths, I have restricted the subject matter of this book to only two branches of textiles: dress and furnishing materials. To have covered all the others would have required a book many times longer than the present one; the choice of these two branches has been dictated by the fact that they are the two which most closely concern the public, for everyone uses dress and furnishing materials.

This book makes no pretence of being a technical work; in it I have endeavoured to give a brief picture of the rise of the British textile industry as a whole, and some description of the chief methods by which cloths are made and finished. Both the historian and the technician will find many omissions and I beg their indulgence for these; I have chosen from the enormous mass of facts those particular ones which seemed, in my opinion, to give the clearest and most understandable picture of both aspects of my subject.

G. L. F.

London, June, 1947.

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The binding and end-paper designs are from textile design by Claude Lovat Fraser.

GRACE LOVAT FRASER

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Everyone knows this nation whose industry and stubborn pride in overcoming every kind of obstacle are beyond all imagination.

RYHINER, Swiss Calico Printer, 1766.

Part 1

SECTION ONE

THE BEGINNINGS

Close relationship of textiles to social and political life—foreign influences—wool exports—cloth exports begin—the staple town—ulnage

IN EVERY CIVILIZED community there are two industries which are the oldest and most fundamental of all: textiles and pottery. The crafts upon which these industries are founded are those first developed by primitive man both fulfil urgent human needs and the essential processes used in them are still basically the same as when they were first invented, though modified and improved by modern machinery and methods.

Through centuries the textile industry has reigned supreme in Britain and here, perhaps more than in any other country, it has coloured and influenced history, foreign relations and domestic policy in the most intense and persistent fashion. Other industries have arisen and flourished here—but the textile industry has led them all and it can be said that, until the coming of the Industrial Revolution and the tremendous upward surge of the heavy industries which this induced, textiles were the most important section of British industry, other types taking a relatively modest part in the scheme of things. It is not for nothing, nor is it merely a quaint survival of a meaningless symbol that the Lord Chancellor, supreme embodiment of British law, traditionally sits upon the Woolsack. The whole of British life, from the earliest times until to-day, has been intimately bound up with the textile industry and for many centuries this was synonymous with the growing, spinning and weaving of wool.

So, though to-day the British textile manufacturer employs his age-old traditions and skilled craftsmanship in the making of fabrics from the whole range of fibres, both natural and synthetic, which are available in the modern world, it is impossible to understand the traditions upon which our textile industry has been built or how it has come about that it is so closely bound up with the pattern of life in these islands, without first of all considering the beginnings and rise of the raw wool and wool cloth trades here. For many centuries wool was the staple fibre and not only was it the foundation upon which both domestic and foreign trade arose and flourished but it was also one of the causes which brought the British Mercantile Marine into existence.

Throughout the history of British textiles there is one constantly recurring factor which has, at intervals, played a vital part in many fresh and important developments; this factor is the arrival in this country of refugee craftsmen seeking asylum from wars and religious and political disturbances on the Continent. These refugees have continued their craft in their new surroundings, often in the face of the most bitter opposition; but always being ultimately absorbed into the body of the home industry, where their ideas and skill have been first assimilated, and then developed in the way for which our native craftsmen have always held the secret, until the work which the foreigners began became a living and indigenous part of British industry. From the days of the arrival of the first Flemish weavers, invited to this country by Edward III, through the later advent of the Huguenots with their skill in silk weaving and of those other Huguenots who founded the great Irish linen industry, down to our own times when men and women flying from the horrors of Hitler's *régime* have once more enriched our native textile skill and brought us new ideas and techniques, this factor has remained one of the strongest influences in British textiles. The strangers and their ideas have been so completely absorbed that the final result has been, not a perceptible grafting, but a new and richer growth of the native craft. One of the major strengths of the British textile industry is this absence of rigidity, this ability to welcome and assimilate new ideas from whatever source, coupled with such native strength of craft and imagination that the fabrics produced under these influences are never other than completely British; to use a trade term, the "handwriting" remains unmistakably British, whatever the source of inspiration.

Little is known of the origin of the arts of spinning and weaving in these islands, but there is evidence that they existed in pre-historic times. This evidence is based on the discovery of some primitive weaving apparatus in the lake-village of Glastonbury and also of pieces of rough cloth resembling baize which have been found in ancient British barrows, as well as a shroud found in a Celtic barrow in 1878, which was plaited so as to form a loose, coarse fabric. Apart from these indications of prehistoric knowledge of these crafts, it is certain that they were brought here by the Romans, and that the knowledge thus introduced, or improved, by the Romans persisted in the country and was developed by the Anglo-Saxons. The Anglo-Saxon women were famous for their skill in embroidery and for their use of gold, silver and coloured silk threads in this, which was generally known as "English work." In these early times the spinning and weaving of flax and wool was purely a domestic occupation and served no more than the needs of the household which produced the goods. But even at that date there were some exceptions to this rule of production for domestic consumption only, and Herbert Heaton in his book, *The Yorkshire Woollen and Worsted Industries*, states that "By the end of the eighth century Mercia was exporting woollen cloaks, presumably made from English cloth, to the realms of Charlemagne, and owing to some apparently fraudulent reduction in the length of the garments Charles found it necessary in 796 to ask King Offa that the cloaks might 'be made of the same pattern as used to come to us in olden time'." But many years were to elapse before the export of English cloth abroad became anything more than a sporadic affair. The quality of the cloths made in this period varied, as might be expected, according to the wealth or otherwise of the household producing them, rough, coarse materials being made in the huts of the poorer people, and cloths of finer quality in the households of rich nobles. Dyes were simple and primitive, made from plants or cockles, or in some cases from madder imported from France.

But if the export of cloth from this country was as yet in its infancy the trade in raw wool was already established in Anglo-Saxon times. In the reign of Edgar, English raw wool was exported to the Continent and under Edward the Confessor the merchants of Rouen had their own dock in the City of London and special regulations were laid down to control this foreign trade.

The Norman conquerors had considerable skill both in weaving and embroidery. William of Malmesbury says: "The shuttle is not filled with purple only, but with various colours, moved here and there among the thick spreading threads, and by the embroidery art they adorn all woven work with various groups of figures."* From early days the whole of the great cloth industry of Flanders was closely bound up with the trade of this country, for it was almost entirely dependent upon supplies of English raw wool. This close mercantile association with Flanders had great influence on English foreign policy and was also sometimes responsible for a certain re-orientation of domestic life; for example, after the Black Death, with its decimating effects, England grew rich and strong again upon the rearing of sheep and on the sale of their wool. The land, which could no longer be tilled for lack of man power, was enclosed as sheep pasturage—two or three shepherds being able to care for flocks grazing on an area of land which would have needed at least forty men to keep in production as tillage.

The spinning and weaving of wool for trade, as well as for domestic needs, was already established by the time of Edward I, and this new and growing industry was having a direct influence upon the living conditions of the people as a whole. The lawlessness of the times, the prevalence of robbers, and the rapacity of the nobles, as well as the sharp practices of the town burgesses, all menaced the industry, upon which the Crown was becoming increasingly dependent as a certain source of extra revenue and loans. Because of its importance in this direction, therefore, it was necessary to endeavour to create conditions at home in which the infant industry could grow with some reasonable degree of security. Trade was beginning to flourish between town and town. Gilds organized and managed the increasing business, and the spinners, weavers, and finishers of cloth began to live peacefully in the towns and their suburbs.

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* From *The History and Principles of Weaving*, by Alfred Barlow.

Gild, guild or geld primarily means a payment and signifies a tax, tribute or mulct. This came to mean a fraternity contributing funds to a common stock or corporation and later this meaning was still further amplified to mean a body responsible for a system of rules by which the particular industry associated with the gild was governed. Although gilds were in existence in Saxon times little or nothing is known of the history of these, but the Commissioners appointed by Charles II to report on the City Companies stated that the most ancient was the Weavers' Company. The woollen weavers paid Henry I an annual rent of sixteen pounds and were granted a charter by him; this was renewed or confirmed by Henry II who also decreed that if any man made cloth of Spanish wool mixed with English wool the portgrave or chief magistrate of London ought to burn it! The clothmaking gilds exercised the most rigid control of the industry until the middle of the fifteenth century; from that time onwards their influence waned for a variety of reasons, until about 1600 it finally ceased.

The organization of the raw wool and wool cloth trades was greatly helped by Edward I, whose Statute of Westminster (1275) gave the merchants their first real chance to develop their trade on orderly lines. This statute fixed a definite rate for the "ancient customs" on exports, imposed taxes on the import of cloth and fixed a "new custom" to be paid by foreign merchants, which was approximately half as much again as the "old custom." Royal officers were appointed to collect these customs at the ports, and this period saw the beginning of the importance of the Cinque Ports, for they and their members were given special privileges and exemptions which had to be compensated for by supplying ships for the use of the Crown. These represented the English Navy of the time and were the direct ancestors of the British Mercantile Marine of to-day. This fostering of the Cinque Ports and their ships shows an awakening awareness of the importance of shipping to British trade, and British export trade at that date could still largely be summed up in the one word—wool.

While these regulations were being laid down, others which affected the organization of inland trade were also made. Towns were generally walled and the gates shut from sunset to dawn; strangers were not allowed to live in the suburbs of a town unless they were vouched for by one of the inhabitants. The verges of the connecting roads from town to town were cleared on either side for a space of two hundred yards, so that robbers could no longer lurk concealed beside them to waylay traffic. The important matter of the recovery of trade debts was also adjusted—the Statute of Acton Burnell (1283) providing for debtors being brought up before the mayor of the town and being made to sign an agreement to pay before a certain date. Failure to do so involved distraint upon the debtor's property in the town or elsewhere. Up to this time the method of recovery had been both cumbrous and unfair, consisting as it did, in applying to the defaulter's gild or of seizing the goods of such of the defaulter's fellow townsmen as could be laid hold of.

In the reign of Edward III the value of English raw wool had greatly increased—from £2 a sack to £8, and wool merchants began to grow in importance. New statutes were passed to regulate trade, among these being the Statute of Staples (1353) which regulated the export of wool. The export of raw wool was a firmly established trade, and the industry of cloth manufacture already a thriving one, though as yet mostly confined to the home market. Some idea of the extent of the raw wool export trade of this time can be gained from the annual value exported, which came to the respectable figure of £180,000, or roughly about £5,000,000 according to to-day's value.

A body known as "The Merchants of the Staple" (founded either under Henry I or Edward I) existed with the object of improving the system of internal trade which till now had been based exclusively on fairs held once or twice a year in such towns as Stourbridge, Leeds, and Winchester. The Merchants of the Staple sold wool, hides, leather and tin, but the sale of wool was the most important part of their business. This system of annual or bi-annual fairs was inconvenient and slowed up trade; the Merchants of the Staple created staple towns where buying and selling could go on all the year round. This new system was also more convenient for the Crown which could thus concentrate its control and customs officers. From the time of

Edward III the Merchants of the Staple held the sole export rights for raw wool and they moved the staple town away from England to the Continental town of Bruges; the move was primarily made to give England the control of the carrying trade, but the unsettled conditions abroad and the prevalence of piracy in the Channel made this experiment abortive, and the staple town was moved back to England and distributed among a number of different centres: Newcastle, York, Lincoln, Norwich, Canterbury, Winchester, Exeter and Bristol all becoming staple towns. All these towns were situated in the heart of the great wool-growing districts; to-day these districts still produce wool but none of the towns are actual clothmaking centres. After ten years the Staple was moved again, this time to Calais (at that time an English possession) and there it stayed for as long as the staple town remained a part of the ordinary machinery of trade.

While these changes and improvements were taking place in the raw wool export trade, the cloth industry, which was destined ultimately to overtake and surpass it, was also moving on. The encouragement of foreign weavers had always characterized the English Crown; Flemish weavers had followed the Princess Matilda to England under William the Conqueror, and Henry I had settled weavers of the same nationality in South Wales. But it was Edward III who, in 1331, took the first big step towards the production of finer English cloth by inviting John Kemp and other Flemish weavers to take up their residence in England, to ply their craft and "teach it to such of our people as shall be inclined to learn it." Not only were the Flemings master weavers but they also held secrets for the finishing of cloth, secrets which they jealously guarded. Indeed, though increasing quantities of English cloth were exported in the thirteenth and fourteenth centuries to the Low Countries, much of it was sent in a half-manufactured state to be finished there. This move on the part of the king was of the first importance to the growing English industry, for he included Flemish fullers and dyers, as well as weavers in his invitation. In this connection it is interesting to read what Fuller, writing three centuries after the event, has to say about it: "The King observing the great gain to the Netherlands by the export of this wool, in memory whereof the

Duke of Burgundy instituted their Order of the Golden Fleece—where indeed the fleece was ours, but the gold theirs—so vast was the emolument by the trade of clothing. The King therefore resolved, if possible, to reduce the trade to this Country, for Englishmen at this time knew no more what to do with wool than the sheep that wear it, as to any artificial or curious drapery, their best cloths being no better than friezes such their coarseness from want of skill in the making."*

Many Flemish weavers accepted the King's invitation and settled first in Norwich; later some of them moved to Westmorland and others to York. But Norwich remained the chief centre of the Flemish weavers, and the cloth known as worsted was first made by them in the little village of that name near Norwich and soon became as famous throughout the country as British worsteds are throughout the world to-day.

Though the Flemish weavers were firmly established in the country and English weavers were improving their own skill by their aid, it is not to be thought that the foreigners were having altogether an easy time of it. Some of the men engaged in actual weaving were glad enough to avail themselves of the Flemings' knowledge, but it was quite another story as far as the rest of the country's inhabitants were concerned. The English distrust of foreigners was already a national characteristic—trouble was always breaking out, protests against strangers living in the heart of the country were made; nor was this all, time and again the age-old cry of "spy" was raised and the most innocent men unjustly suspected or accused of this activity. But the strangers stood fast and went about their business and in time became accepted and absorbed into the country's life.

As the wool trade increased, more and more land was enclosed for sheep pasturage; often this enclosure was unfairly carried out and the men and women who had lived by the produce of the land found themselves turned adrift from it; this led to many civil disorders. But the fact remained that English wool had, as yet, no serious rival, and it continued to be produced, and sold abroad in ever-increasing quantities, while English wealth grew apace. But it was wealth acquired at the cost of a reduction in the number of actively employed workers in the country, and a new

* From *The History and Principles of Weaving*, by Alfred Barlow

class of people began to appear—a pauper class which had no fixed or permanent means of livelihood. But the wool merchants had grown so rich and powerful and the wool trade was so firmly entrenched in the life of the country that neither recurrent civil disorders nor the misery of some of the population could in any way check its progress.

It is true that from the death of Edward III the export of raw wool had begun to decline, but this was only due to the fact that the English cloth industry was firmly enough established and sufficiently productive to allow of ever-increasing exports of cloth as well as meeting domestic needs. Stamford cloth was used as far afield as Venice, Yorkshire had already laid the foundations of its fame abroad as a great woollen cloth producing centre, and woollens from Wales were also being exported in small quantities. England continued to produce as much, if not more, wool as ever, but a large part of this was now absorbed by the home cloth industry, instead of being sent abroad to be manufactured there. The English weavers were learning the lesson which the Flemings had been brought over to teach them.

The industry had grown widespread, worsteds were being made in other towns than those of their origin, and all over the country new centres of clothmaking were springing up. All these were in the great wool-growing districts, Norfolk, Suffolk, Somerset, Dorset, the Cotswolds and the West Riding of Yorkshire. Lancashire also was beginning to supply the foreign markets; up to this time the cloth produced in this area—linens and cheap woollens known as "cotton"—had been entirely used for local consumption. As soon as the cloth industry began to expand in this county, its organization was conditioned by the fact that the increased supplies of raw material needed could not be all home grown; the wool clips from the surrounding flocks and the flax grown in West Lancashire were no longer sufficient for the needs of the growing industry. So extra raw materials began to be imported from various home counties and from Ireland and these essential imports influenced the whole trend of the textile industry in this county. But this phase of its expansion and growth belong to a later section.

Even before the impetus given to English clothmaking by the settlement of the Flemish weavers, the industry had been subjected to numerous regulations which sought to impose standards of quality, of length and of breadth (a width clause even appearing in Magna Carta), but none of these had been very strictly enforced, the weavers disliking such restrictions and the English merchants finding them, for the most part, inconvenient and irksome. Also it had not been found possible to enforce them in regard to imported foreign cloths and this tended to weaken the control exercised on home-produced materials.

But the industry had at last grown sufficiently important to need governmental, rather than local, control and this for two reasons: firstly to prevent dishonesty of manufacture such as the use of flocks and inferior materials in weaving, or the mixture of various kinds of wool or standards of spinning in one piece of cloth, the use of two qualities of weft in one piece (a good one at either end and an inferior one in the middle), or over tentering, all of which malpractices were bringing English cloth into disrepute abroad as well as at home. Secondly, so as to regularize the revenue from clothmaking upon which the Crown was becoming more and more dependent, as its revenue from the export of raw wool decreased owing to its increasing use in cloth manufacture at home.

Regulations were issued in an attempt to impose standards of quality, length and breadth on different types of cloth; at least on those of the better sort, for the regulations took, at first, no account of the poorer qualities such as "Cogware" or "Kendal cloths" which were used by the poorer classes and were of such low quality as to make it unprofitable either to control them or to levy taxation from them. But the regulations were difficult to implement, they were unpopular and London was a long way from the weavers who were scattered about the whole countryside. Also the merchants commissioned cloths in order to sell them at a profit and this profit was not always obtainable if the letter of the law was too strictly adhered to. It was obvious that some sort of machinery must be set up to enforce the regulations.

This was done at first by appointing two officers of the Crown whose function it was to view all cloths offered for sale (whether of home manufacture or imported, for by this time the regulations as to width and length had been made to apply to the latter as well), and to confiscate all materials which did not conform to the regulations. A little later this work was transferred to the hands of a single officer (generally appointed for his lifetime) who was called an "ulnager," a name derived from the word "ulna" which means an ell of 45 inches length. The ulnager's work consisted not only of enforcing the regulations as to standards but also in collecting the monies levied on all better quality cloths offered for sale, which were known as "cloths of assize." This levy consisted of an ulnage fee of a halfpenny, plus a subsidy of fourpence on each whole cloth of excise or of sixpence in the case of scarlet cloths. The ulnager's powers covered the whole of England and Wales and in order to exercise them efficiently he was empowered to appoint a number of deputy ulnagers who were responsible to him and to whom were assigned definite districts such as Yorkshire, or Lincolnshire, a deputy ulnager being appointed for each clothmaking district in the country. These deputies lived in their respective districts and no cloth could be offered for sale which had not first been examined and sealed by the local official. If any taxable cloth were offered for sale without having first been so examined and sealed, it was liable to confiscation, being taken to the Tower of London, there to be disposed of as the king might see fit.

The standards of length and breadth were always unpopular and from time to time the regulations concerning them were relaxed and then re-imposed, until in 1393 an Act was finally passed which permitted the making of any kind of cloth of any breadth or width whatsoever, provided it was first searched and sealed by the ulnager before sale. By this Act the ulnagers, from being both tax collectors and supreme arbiters as to cloth standards, became purely financial agents of the Crown whose sole function was the collecting of the various taxes imposed upon cloth. In actual fact this had always been their most important task. The new Act imposed the sealing of, and collection of taxes on, even the poorer grades of cloth which hitherto had been exempt, but the taxes on this type of goods were apparently seldom collected throughout the whole of the fifteenth century.

The cloth industry was beginning to overtake the raw wool trade; in the course of the next two centuries it was completely to surpass it. In the middle of the fourteenth century wool exports were 30,000 sacks a year and cloth exports about 5,000 cloths. By the middle of the sixteenth century the wool exports were 4,000 sacks and the cloth exports well over 100,000 cloths.*

Such, in brief, is the outline of the beginnings of the textile industry in this country. As it grew and expanded various forms of regional specialization took shape. Wool for long retained its lead but other fibres were to be developed into materials upon which thriving new sections of the industry would ultimately grow to proportions of equal importance to wool. The sections which follow will be concerned with this growth of regional specialization and with the rise of the rival textile fibres.

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* See E. E. Rich· *The Ordinance Book of the Merchants of the Staple*

SECTION TWO

GROWTH

Industrial revolution in the fifteenth century—gild control—domestic system—early factories—the Flemish settlement in Norwich—effect of the Civil War—depression after the Restoration, and gradual recovery

ENGLISH CLOTH EXPORTS continued to increase throughout the whole of the fifteenth century, so much so, indeed, as to seriously affect the trade of the clothmaking Low Countries. Ypres, for instance, had in 1408 what for mediaeval times was the large population of eighty thousand, of which three to four thousand were cloth workers. By 1486 this population had diminished to less than six thousand and there were only something between twenty to thirty cloth workshops left in operation.* England was not only clothing herself, but also supplying all the known markets of the world; from being a country with an export trade mostly devoted to supplying wool for foreign manufacture she had become, in the short space of less than a hundred years, a leading industrial nation. It is the custom when considering the English textile industry to lay great stress on the re-orientation which took place at the end of the eighteenth and beginning of the nineteenth centuries and which was caused by the mechanical inventions of this period and the consequent industrial revolution. Vital and far-reaching as were the effects of this, they should not blind us to the equal importance of the industrial revolution which took place during the fifteenth century. Not only did this revolution profoundly affect the trade of this country for the better, it also changed the whole course of its agriculture, the chief produce of which became sheep instead of corn—a change which altered many aspects of English life, both social and economic.

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* See *Town Life in the Fifteenth Century*, by Mrs. J. R. Green.

This increase in export trade was accompanied by a change in the internal organization of the industry. The clothmaking gilds were in complete control of the industry until the beginning of their decline towards the middle of the fifteenth century. Gild control continued to be effective in the towns, whilst growing progressively weaker in the countryside, until by 1600 it finally lapsed everywhere. Gild activities were fourfold: industrial, religious, charitable, and social; only the first of these need concern us here. Their regulation of the industry was strict and dealt with such matters as hours of work, Sunday and night work, and the regulation of wages and selling prices. The gild assumed responsibility as a body for the work of all its members and ordinances were framed to encourage high standards of workmanship and to punish dishonest or faulty work. These regulations were implemented by a system of workshop inspection and control; goods which did not reach gild standards were liable to confiscation and the punishment for such work might be either a fine, the pillory, or in extreme cases, expulsion from the gild. Many clothmakers found these controls irksome and at the end of the fourteenth century there began a move away from the cities to the countryside, where the gild control was, of necessity, laxer. This exodus to the country continued throughout the whole of the fifteenth and sixteenth centuries and many important industrial cities of to-day grew from villages to towns owing to the settlement of the cloth workers in and around them; such towns are Manchester, Worcester, Bury, Bolton, Leeds, and Birmingham. But apart from the clothmakers' dissatisfaction with the gild control, there were other and stronger reasons for the breakaway from them and their consequent decay. The gilds were losing their usefulness, for clothmaking is not one, but a combination of many crafts such as spinning, weaving, fulling, dyeing, and finishing. The gilds were no longer capable of satisfactorily ruling and co-ordinating all these separate crafts under the expanding trade conditions of the time, for their framework was too narrow and rigid. They were also ill-adapted for dealing with the increasing volume of export trade, for they were so hedged about with restrictions and regulations as to make their handling of this both clumsy and complicated. Finally the cloth produced under their auspices was higher priced than that made in the rural areas and smaller towns where the cost of living was not only lower, but where there was also an ample source of potential labour in the people who had been dispossessed as a result of the change in agrarian policy. Herbert Heaton in his book, *The Yorkshire Woollen and Worsted Industries,* quotes the following account of the plight of York at this time which was written by a contemporary inhabitant of the city: "The cause of the decay of the . . . weavers and looms for woollen within the sayd cite as I doe understand and learne is the lak of clothmakyng in the said cite as was in olde tyme accustomed, which is nowe encreased and used in the townes of Halifax, Leedes and Wakefield, for that not only the comodytie of the water-Mylnes is ther nigh at hande, but also the poore folke as speynners, carders, and other necessary workfolkes for the sayd webbing, may ther besyde ther hand labor, have rye, fyre, and other releif good cheape, which is in this cite very deare and wanting." Some different form of organization was needed to co-relate the different processes and to market the goods thus produced, and this necessity ultimately led to an entirely new system of manufacture and sales organization; this was destined to completely supersede the old gild pattern and to control the industry until the mechanical inventions of the eighteenth and nineteenth centuries reversed the order of things, and once more brought the workers back to the towns.

This new system is known as the domestic system and it was controlled, not by a gild or fraternity of workers, but by a capitalist. This capitalist, known as a "clothier" bought the wool, took it to the spinners, from them to the weavers, and from these collected the woven cloth. At this stage he either sold it in its "grey" or unfinished condition or arranged to have it passed through the operations of scouring, fulling, tentering, and dyeing before disposing of it. The various craftsmen lived in the country or the small, unimportant towns and worked, for the most part, as heretofore in their own homes, often assisted by members of their family. The whole burden of costs was carried by the clothier who added his own charges for warehousing and marketing to the standard prices for raw wool and the different manufacturing processes.

The clothmaking industry was scattered all over the country in the great sheep rearing districts: Westmorland, Lancashire, Devonshire, Gloucestershire, Worcestershire, Wales, Norfolk, Suffolk, Sussex, Essex, Kent, Somerset, and Berkshire. Not all these districts were of equal importance, many of them such as Wales and Lancashire producing, at this time, only the lower qualities of cloth and chiefly for their own consumption. In the fifteenth century the western counties of Somerset, Gloucestershire and Wiltshire were between them the greatest producers of cloth in England, averaging together over twelve thousand cloths a year and these of the best quality made in the country. Next came Suffolk, with slightly more than five thousand cloths a year and Yorkshire with not quite five thousand. These five counties led the field and produced sixty-two per cent of England's total yearly output.*

The domestic system developed somewhat differently in the west and north of England. The west-country clothier was a capitalist and *entrepreneur* who personally took no part in the manufacture of the goods he handled and whose activities were purely commercial. He worked on a large scale, lived in ample style in a large and beautiful house, dispensed lavish hospitality and might even, on occasion, entertain the king and his court. In the northern districts the situation was different, for though some of the clothiers worked on a big scale, they were usually small to middling men who took some part in actual manufacture. There was very little social difference between them and the men they employed; the cloth was mostly made in the workers' homes but sometimes in the clothier's own house, either by him and his family or, if he were in a slightly better way of business, by a number of employees brought together by him and whose work he controlled. This lesser type of clothier was still responsible for buying and distributing the wool and for paying the different operatives for their work; but many such clothiers found difficulty in laying their hands on enough money to buy wool in any large quantity. This circumstance gave rise to a class of middlemen whose function was the buying of wool in quantity direct from the grower and re-selling it to the smaller clothiers as they needed it. The whole system was elastic and capable of many variations but some kind of commission basis always existed, with one man in authority who co-ordinated the various processes, carried the financial burden and marketed the finished results. The rich clothiers were concerned with the higher class of home market and with export and, unless they were merchant exporters, used the services of a factor for the sale of their goods. The smaller men were usually their own salesmen and their outlets were the local weekly markets.

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* See *The Yorkshire Woollen and Worsted Industries*, by Herbert Heaton, M.A.

By the end of the fifteenth century, England was largely a nation of sheep farmers and clothmakers, and civil disturbances seem to have made little or no difference to the industry. During the Wars of the Roses, though heavy fighting took place in and around some of the centres of the wool trade, this does not seem to have disturbed them unduly and ordinary business was not seriously impaired. J. R. Green, in his *A Short History of the English People*, emphasizes that these were essentially wars fought by the barons and their followers and that the bulk of the population remained aloof from them and continued their ordinary occupations.

Though the chief centres of the cloth trade were well defined, it was not restricted to these areas alone; wool could be bought almost anywhere in the country, and besides the regular weavers whose full-time trade it was, there were many cottars who owned a loom at which they worked in their spare time. The weavers, except when producing for their own use, worked with material which was not their own but supplied to them by the clothiers; but the looms were generally their own property. The full-time weaver did not, as a rule, confine his work to one clothier but might have as many as two to four customers for whom he made cloth and sometimes might own as many as six looms. Fulling mills were scattered up and down the country wherever there was a suitable stream; these mills were generally owned by the lord of the manor on whose land they stood and leased by him to the fullers. Dye mills were equally scattered and also held on leasehold from the lord of the manor; sometimes several dyers worked in one district, sometimes the landlord granted a monopoly to one man. Women worked in all the different branches of clothmaking besides their own traditional craft of spinning. There was considerable opposition to women cloth workers and in the fifteenth century this opposition was based on the ground "that they competed with men who were said to deserve the chief consideration since they did 'the King service in his wars and in defence of the land'; it was also alleged that women were not of sufficient power to weave certain kinds of cloth."* But in spite of this opposition women remained active in many branches of the industry, generally as assistants to their husbands, helping to work the broad loom which needed two operatives, acting as fuller's assistants or even sometimes as heads of dye mills. But it is probable that the women who appear in old documents listed as weavers or dyers in their own right were widows carrying on their husband's old trade, a right which was always granted to them. In York, women clothmakers were admitted as Freemen of the city, none but Freemen being allowed to work at the craft within that city.

Such was the picture presented by the textile industry in the fifteenth and early sixteenth centuries—the workers more and more tending to desert the towns for the country, the gilds still exercising control over the master weaver, his journeymen and apprentices in the towns, but with their power on the wane and daily encroached upon by the new class of wealthy clothiers, and with the cities diminishing in wealth and importance as their manufacture and trade dwindled. But it should not be thought that the clothmaking gilds relinquished their supremacy over the industry without a struggle or that the town craftsmen were content to see their country brethren so much more busily employed than they. The town workers were loud in their complaints—the gilds did more than complain. The cities of Norwich, York, Shrewsbury, the five principal clothmaking towns of Worcestershire and the three principal ones of Somerset, between them secured legislation designed to prevent clothiers from settling in the country around them or foreigners from dealing direct with the rural industries. But none of the expedients resorted to by the vested interests of the gilds—legislature, municipal regulations, or the forming of chartered corporations—could stem the rising tide of the domestic system or prevent the victory of the country over the towns. In the north a long and bitter struggle which lasted for a hundred and fifty years between the cities of York and Beverley and the West Riding of Yorkshire culminated in the triumphant emergence of the country district as the greatest cloth producing area in the north of England, a position which it enjoys to this day. In 1555 and 1557 two Acts were passed, known as the Weavers Acts, which were framed to consolidate the protection which previous legislature had already sought to extend to the cities. The Act of 1555 says: ". . . the weavers of this realm have complained that the rich and wealthy clothiers do in many ways oppress them; some by setting up and keeping in their houses diverse looms, and keeping and maintaining them by journeymen and persons unskilful, to the decay of a great number of artificers which were brought up in the science of weaving, their families and households; some by ingrossing of looms into their hands and possession and letting them out at such unreasonable rents as the poor artificers are not able to maintain themselves . . ." and goes on to forbid clothiers who *lived outside towns* from keeping more than one loom, or woollen weavers more than two. But whole districts of the rural section of the industry were perforce exempted from the restrictions of these Acts, the whole of the northern counties, as well as Wales, Cornwall. Suffolk, Kent, the Stroud valley, Essex, Wiltshire, Somerset and Gloucestershire remaining free areas.

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* From *The History of the English Woollen and Worsted Industries*, by E. Lipson, M.A.

By the end of the fifteenth century the domestic system was firmly established, though the struggle between town and country still continued. Though the bulk of the work was done in the weavers' own homes, the latter part of the century and the beginning of the next saw a few instances of weaving organized by the clothiers on something very like a factory system, with a large number of looms set up in one house and operated by hired weavers. The most famous instance of this early factory system was that set up in Newbury by the wealthy clothier John Winchcombe, who died in 1520. This pioneer has become a legendary ballad hero under the name of Jack of Newbury and is reputed to have led a hundred apprentices to the battle of Flodden Field. He is also thought to have been one of the first to introduce the new broad loom. Thomas Deloney, in his ballad *The Pleasant History of John Winchcombe* gives the following description of this factory:

> "Within one room being both large and long,
> There stood two hundred Looms full strong;
> Two hundred men the truth is so
> Wrought in these Looms all in a row.
> By every one a pretty boy
> Sate making quills with mickle joy.
> And in another place hard by,
> An hundred women merrily
> Were carding hard with joyful cheer
> Who singing sate with voices clear."

An early instance of music while you work! Whether or not the numbers of people employed by John Winchcombe were as large as the enthusiastic ballad writer makes out, he died a very rich man whose house, after his death, was converted into no less than sixteen separate houses and dwellings. His son later acquired Abbey property and a seat in Parliament. John Winchcombe's memory is still kept green in Newbury where one of the principal inns is called the *Jack of Newbury*.

There were other instances of the factory system—that of William Stump who rented Osney Abbey in 1546 and proposed to employ no less than two thousand workers; that of Tucker of Burford who sought the patronage of Thomas Cromwell in 1538; and that of Dolman of Newbury whose workmen sang despairingly when he retired from business:

> "Lord, have mercy upon us, miserable sinners,
> Thomas Dolman has built a new house and turned away all his spinners."*

But such early instances of factories were exceptional; the feeling of the time was against them and in favour of the independent worker who carried on his trade in his own home, and the Government viewed them with suspicion and distrust as affording too good an opportunity for the congregation of lawless and disaffected persons.

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* From *The History of the English Woollen and Worsted Industries*, by E. Lipson, M.A.

In tracing the development of the cloth trade in general, and of the domestic system in particular at this period, the settlement of foreign workers has been left to one side, and it is now time to return to this. In Norwich the Flemings brought over by Edward III had become absorbed into the city's life and the cloth trade had flourished to such an extent that at the beginning of the fifteenth century it ranked as the second city in the kingdom. At about the same time as John Kemp and his followers had settled in Norwich, another group of Flemings had become established in the Welsh county of Pembrokeshire. Here they set up cloth workshops on the Low Country model and soon there were similar shops in nearly every valley in Wales. The Welsh cloths had only a very limited export, and were almost wholly produced for home consumption, this condition of affairs continuing until the end of the eighteenth century. The cloths were rough and coarse in type, very suitable for hard wear and were later to be developed into the famous Welsh flannels. In 1486 Henry VII, becoming concerned at the decay of the cloth industry in the towns, attempted to infuse new vigour into the urban industry by inviting a large number of the most skilled cloth workers in the depressed Low Country areas to settle in England. In 1551 the Protector Somerset established a colony of weavers, mostly Flemings, at the Abbey of Glastonbury. This settlement was ill-starred from the first, for the fall from power of the Protector occurred soon after their arrival. Edward VI appointed a Commission to inquire into the matter and their report being favourable, building work was put in hand to house the forty-six families which were living huddled in six houses; dye houses were set aside for their sole use and money advanced to them with which to buy wool and dyes and with which to pay wages. The weavers became naturalized and claimed the rights of English subjects as to taxes and their own gild government, but the ill luck which had dogged them beset them once more, for Edward died before any of these requests were granted and the colonists packed up and departed to Frankfurt.

Meanwhile Norwich had fallen upon hard times, due partly to the growth of the domestic system, but chiefly because of the ravages caused by fire and pestilence and Tanner Kent's rebellion; by the middle of the fifteenth century it had fallen to sixth place among English cities, and in 1555 grass was growing in its market place. The situation was retrieved in 1565 by the advent of a fresh colony of weavers from the Low Countries. The group which settled in Norwich was part of a large number of emigrants who were seeking refuge in England from the cruelties and oppression of the Duke of Alva in his attempts to suppress the Reformation. The refugees were welcomed by Elizabeth and brought with them numbers of the most skilful and industrious craftsmen. Their coming marked a new era in the English textile industry for they were makers of finer cloths (known as the "new draperies") than had ever been made in this country before. They settled in various parts of the country—Colchester, Ipswich, Halstead, London, Canterbury, Maidstone, Stamford, Yarmouth, Manchester, Thetford, Sandwich, Southampton, and notably in Norwich. Elizabeth granted letters patent to the Duke of Norfolk which authorized the Mayor and Corporation of that city to receive "therty Douchemen of the lowe countreys of Flanders, alyens borne all being householders or maister workmen" and who were permitted to bring with them their families and servants, the latter not to exceed two to each family. The strangers were to exercise "the faculty of making bayes, arras, sayes, tapestry, mockadoes, staments, carsays and such outlandish commodities as hath not bene used to be mayde within our Realme of England." (Bayes was a fine, light-weight woollen cloth, arras a tapestry cloth, sayes a fine wool cloth something like serge, staments a coarse worsted, carsays a form of kersey; mockadoe was a material made of a mixture of silk and wool or of linen and cotton, with a figured design woven in tufts and cut in imitation of figured silk velvet. It was quite unknown to English weavers until the arrival of the Flemings; its name still lingers in cloth nomenclature to-day as "moquette." The bayes and sayes mentioned were not new, but probably the Flemish materials of the type were an improvement on those already made in this country.)

But in spite of the prospect of renewed prosperity which the strangers brought with them, the usual ill-feeling at the arrival of the foreigners arose wherever they settled. At Norwich the members of the city's Common Council refused to admit them under their common seal, so that the mayor was obliged to agree that the Mayor's Seal should be fixed to the "Writing of every thurty maisters that be lycensed according to the letters pattents." Though the strangers were described as "Douchemen" a number of them were Walloons, a French-speaking race, so though the new settlement of weavers was of the reformed church it differed considerably within itself as to language and codes of law. Each community had its own church, cloth halls and sealing halls and the kind of cloth to be made by each was also regulated, the Dutch being allowed to make what were described as "wet, greasy goods" and the Walloons "dry, woven goods."

Ill-feeling against the foreign weavers continued for a number of years, the city authorities first trying to force them to sell to freemen only, then the mayor attempting to expel them entirely, though the Town Council refused to agree to this. Troublesome regulations were imposed, and a complaint made to the Privy Council that there were one thousand, one hundred and thirty-two foreigners settled in the city, a number far in excess of that originally permitted. The shearers of worsted complained loudly that because of the new draperies their work was nearly gone and a culminating mark of displeasure was the organization of a sort of pogrom by a certain John Throckmorton and his followers, which mercifully did not succeed but which was serious enough to warrant the interference of Elizabeth. Finally a "Book of Orders" was drawn up to regulate the Flemings' occupation and among other things they were authorized to trade with both freemen and foreigners. But the opposition to them was so determined that they found it necessary from time to time to get the mayor to issue certificates as to the advantages of their residence in the city. Some extracts from such a certificate are as follows:

"*Imprimis*. They brought a grete commoditie thether, viz: the making of bayes, moccadoes, grograynes, all sorts of tufts etc. which were not mayd before, whereby they not only set on worke there owne people but do also set on worke there our owne people within the cittie as also a grete number of people nere XX myles about the cittie.

Item. By their means our cittie is well inhabited and decayed housen re-edified.

Item. The Marchaunts by their commodities have grete trade as well within the realme as without the realme, being in good estimation in all places.

Item. They be contributors to all paiements or subcedies, taskes, watches, contribusion, mynisters, wagis etc. They live holy of themselves without charge, and do begge of no man and do sustain their own pore people . . ."

The document ends with the words ". . . and we thinke our cittie happie to enjoy them," and is endorsed "The benefittes receaved in Norwich by having the Straungers there."*

There can be no question but that the strangers had restored prosperity to Norwich; before their arrival the number of cloths sold by the Rusel Company of Weavers had sunk to only slightly over two hundred a year, by 1572 the number had risen to two thousand, eight hundred and forty-five. The strangers continued to increase in numbers—in 1572 the original thirty families had become four thousand people, in 1578 there were six thousand Flemings living in Norwich. Opposition to them had subsided and they had become members of the community, taking full part, for instance, in the ceremonies organized to welcome Elizabeth on her visit to the city in 1578, when the strangers presented her with a cup worth fifty pounds. They remained, however, somewhat quarrelsome amongst themselves, especially over the identity of the inventors of new fabrics, many lawsuits based on these grounds being recorded in the city archives.

The subject of silk weaving in Great Britain is dealt with in the next Section but it is necessary to touch briefly upon it here to complete the story of the Flemings in Norwich. Silken cloths had long been known in England but there was no native manufacture of them until long after the wool and worsted cloth trades were great and flourishing. A few all-silk materials and some made of a mixture of silk and other yarns were made in Norwich from the middle of the sixteenth century onwards; mockadoe with its mixture of silk and wool has already been mentioned. In 1575 the Flemings introduced a new cloth called bombazine which somewhat resembled a light poplin and had a silk warp and either a linen or cotton weft. There was a good deal of wrangling over this invention, the Dutchmen and Walloons both laying claim to it. The number of silk cloths made in the city increased after the last and most important Flemish refugee immigration which took place after the sack of Antwerp, when about a third of the manufacturers and merchants of this city fled to England. Amongst these refugees were many skilled weavers of damask and other silk materials and this would account for the appearance of a number of new silk cloths mentioned in a list, dated 1611, which catalogues the new materials introduced by the strangers. This list is worth quoting, with its queer fantastic names of cloth, to show how many and varied were the fabrics made by the now completely established Flemings. In this list they are described as making: "bays, fustians, parchmentiers, camientries, tufted mockadoes, currelles, tooys, bussins, valures, all of linen, cruell, carlettes, damaske, sayes of dry and cruell, (after the fashion of Lille, of Amiens and of Meaux), dry grograynes, double mockadoes, ollyet, bum-bassines of taffety, *all silk* striped sayes, broad lyles, Spanish sattins, cross billets of *silk*, serge de boyce, *silk* sayes, striped tobines figuartoes, purled and other outlandish inventions."* (The italics are mine.) But though silk was woven in this country at the dates which have been given, it was not until the later arrival of the Huguenot refugees that it was to become a real branch of the English textile industry.

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* *Book of Orders, Norwich.*

The impetus given to the English wool and worsted industries by the settlement in this country of the Flemish weavers was to a great extent nullified by the Civil War of the seventeenth century. But even before the outbreak of war, symptoms of distress are to be marked, the clothiers complaining of the high price of wool and of the way in which the Merchant Adventurers' monopoly of the export trade was managed, the chief cause of complaint against this company being that in order to maintain high prices for its merchandise abroad, it exported in limited quantities and thus bought insufficient cloth from the clothiers to allow them to carry on business profitably. This restricted buying of cloth naturally affected the weavers as well, and during the first years of the century there are numerous instances of weavers petitioning the justices for work. Everywhere production, instead of proceeding steadily, was fitful and irregular, and the outbreak of the Civil War made conditions in the industry even worse; at its close the clothiers of Stroud declared that they "were utterly undone."

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* From *The Silk Industry*, by Sir Frank Warner, K.B.E.

The Restoration, though bringing more stable internal conditions to the country, did not at once restore industry or trade to their former high levels and the years immediately following it were characterized by recurring intervals of depression. Throughout the reign of Charles II, conditions fluctuated in this way and in 1663 a Committee was appointed to inquire into "the reasons for the generall Decaye of Trade" and another Commission was formed in 1669 to consider "the causes and grounds of the fall and decay of trade."* It is not surprising that recovery was slow, for the country was exhausted after thirty years of war and there was besides another grave difficulty to overcome—the war with the Dutch. During this time the presence of the Dutch fleet in the North Sea, and its harrying of such trading vessels as ventured out, was a grave impediment. And even after the end of this war, the Dutch carried on a relentless campaign directed towards excluding finished English cloth from their markets, only allowing the import of English raw materials or semi-manufactured cloths. Other Continental markets were also difficult of recovery for there was everywhere a strong tendency towards self-sufficiency. But though France and Holland might exclude English cloths in order to strengthen their own textile industries, they still stood in great need of such English products as wool and fuller's earth, which was both abundant and finer than any produced elsewhere, and every means, both licit and illicit, was employed to obtain them. The growth of such rival industries was a source of constant anxiety and the export of such raw materials as wool or fuller's earth stringently forbidden; but smuggling out of the country was very prevalent. Another danger was the tendency for countries such as Russia and Prussia, not hitherto the homes of important textile industries, to attempt to organize these with the help of English technicians, who were tempted to undertake such work by handsome financial inducements. A reversal, in fact, of our own classic practice which was hard to bear! The trade in cheap Lancashire woollens was also going through a difficult period, for France, which had always been one of the best markets, had now learnt how to make these and was producing them in quantity at Lille. Not only was France making such cloths for her own use, she was also becoming a serious competitor with them in the Turkish and Levantine markets. Nevertheless, the English textile industry gradually recovered and an era of prosperity began during the last decade of the seventeenth century, 1690 to 1760 being years which were especially favourable to the West Country and Norfolk. The manufacture of serge in Devonshire also greatly increased, the serge market at Exeter growing to be the second largest cloth market in England. During the whole of the eighteenth century Yorkshire was steadily forging ahead towards the outstanding position it was to attain and hold until to-day. Daniel Defoe in 1727 describes a journey to Halifax in this way: ". . . and so still the nearer we came to Halifax we found the houses thicker and the villages greater in every bottom; and not only so but the sides of the hills which were very steep everywhere were spread with houses; for the land being divided into small enclosures from two acres to six or seven each, seldom more, every three or four pieces of land had an house belonging to them.

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* See *The Yorkshire Woollen and Worsted Industries*, by Herbert Heaton, M.A., M.COM.

"In short, after we mounted the third hill we found the country one continued village, though every way mountainous, hardly an house standing out of speaking distance from another; and as the day cleared up we could see at every house a tenter and on almost every tenter a piece of cloth, kersey or shaloon, which are the three articles of the country's labour . . . Such it seems has been the bounty of Nature to this country that two things essential to life, and more particularly to the business followed here, are found in it and in such a situation as is not to be met with in any part of England beside; I mean coal and running water on the tops of the highest hills. This place then seems to have been designed by providence for the very purposes to which it is now allotted for carrying on a manufacture which can nowhere be so easily supplied with the conveniences necessary for it." This is still no bad description of the neighbourhood to-day, except that the tentering frames have disappeared. Of the cloth market at

Leeds, Defoe says: "But the cloth market is to be admired as a prodigy of its kind and perhaps not to be equalled in the world. The market for serges at Exeter is indeed a wonderful thing and the money returned very great; but it is there only once a week whereas here it is every Tuesday and Saturday. . . . Thus you will see £10,000 or £20,000 worth of cloth and sometimes much more bought and sold in little more than an hour, the laws of the market being the most strictly observed that I ever saw in any market in England." The reasons given by Defoe for the greatness of the market are the large amounts of cloth exported to the American Colonies, to Prussia, Russia and Holland, and also the improvements made in the waterways which carried the goods to the port of Hull for shipment overseas. In 1750 the number of broadcloths made in Yorkshire was 60,477. In 1770 the number had risen to 93,075, in 1790 it was 172,588, and in 1800 more than 285,000.*

* See *The Golden Fleece*, by S. W. Morris, M.A.

SECTION THREE

SILK

Origin of silk manufacture in Europe—early English silk weaving—broad and narrow branches—introduction of silk manufacture to France and the Low Countries—Huguenot refugee settlements in England—Spitalfields—Norwich—Coventry—Leek—Canterbury—Macclesfield—Essex

SILK MANUFACTURE in Great Britain has never shown the steady forward pace of wool and worsteds; it is true that the manufacture of the latter fibres declined in some districts, but this was generally due to their advance in some other part of the country. Often this kind of clothmaking revived again in those very places where, at one time, it seemed to be most completely on the downward grade; many of the great wool and worsted centres of to-day can trace over four hundred years of unbroken production. The case of silk is quite different; it was an alien growth which sometimes flowered brilliantly in one district, only to vanish completely, then re-appearing elsewhere and repeating the same brief flowering. In some parts of the country silk took firm and lasting root but in such cases it was of slow growth, continually under the shadow of competition from cheaper silks imported from the Orient or elsewhere, or from the sturdier textiles with which British industry would seem to have a closer natural affinity. This does not alter the fact that silk cloths of the finest design and workmanship have been, and still are, some of the most beautiful that this country has ever produced; but they are rarer than cloths made from other fibres and this section of the industry has never had the volume of production of the other branches. The rise, decay or continuance of various British silk industries will be described in this Section; though this branch of manufacture was to be found in many other places than those mentioned here, they have been omitted as their prosperity was short-lived, and they had little or no influence on the industry as a whole. The examples cited have been chosen because, taken together, they form the real history of British silk.

The history of European silk manufacture begins in the twelfth century when Oriental silk weavers settled in Italy and Sicily. These countries, and later Spain, were to keep the secrets of this manufacture almost inviolate for three hundred years, during which time they supplied nearly all the silk materials used in Europe. The weaving of silk is divided into two branches—the broad and the narrow—all dress and furnishing cloths, (of no matter what width) belonging to the first, and ribbons, braids and cords to the second. The origins of broad silk weaving in England are difficult to trace, but it is extremely unlikely that such materials were made here at all before the fourteenth century, and then only exceptionally. On the other hand the narrow branch of the industry was in production in England from the time of the Norman Conquest at least, the workers being mostly women and children. This industry manufactured thread from raw silk, twisted silk and metal threads together for embroidery work, and produced ribbons, cords, trimmings, girdles, and purses. The number of people thus employed was considerable, for at this early date all ribbons and cords were made in single widths. In 1455 a company of women in London, who were occupied with throwing and spinning silk, petitioned Parliament, stating that the Lombards and other Italians imported such quantities of thread and ribbon into the country that they were becoming impoverished. Accordingly an Act "designed to protect the home workers in the Mysteries" was passed which prohibited the import of "wrought silk, wrought ribbands and laces." Eight years later this Act was extended, and in 1482 it was again extended and the wearing of such imported narrow goods was also forbidden. There is no evidence of broad silk weaving in England until 1461 when a lawsuit was brought in London by an Italian weaver described as a maker of "cloths of damask, velvets, cloth of gold and silver and of other cloths of silk . . . at Westminster . . ." but that this was exceptional would seem to be proved by Bacon's statement in his *The History of Henry VII*, that all silk fabrics, other than the narrow, were imported at that time as there was no manufacture of them in England.* Italy and Spain still retained their virtual monopoly of this branch of the textile industry.

Towards the end of the fifteenth century Italian refugees settled in France and brought the art of silk weaving to that country; it was also introduced into the Low Countries at about the same time. The Flemish weavers soon acquired great skill in this new branch and the cities of Mons, Mechlin and Bruges all became famous for their large-scale production of fine silk materials. Among the Flemish weavers who settled in England, were weavers of both silk and linen, and these settlers are reputed to have been the first to introduce into this country the draw loom for silk and linen pattern weaving. But silk, as yet, played only a small part in English textile production.

Seri-culture and silk weaving flourished in France and by the middle of the sixteenth century the French cloths, at first made on the Italian model, had developed their own special characteristics, especially in regard to elaboration of textures. Tours and Lyons were the centres of this new manufacture and here taffetas, velvets, brocades, cloths of gold and of silver as well as ribbons were made, which were of finer quality than those produced elsewhere. But the centres of the new industry were also centres of the reformed religion and the silk weavers suffered, like all their other co-religionists, from the persecutions which finally led to the Massacre of St. Bartholomew. During this period a few French refugees arrived in England, landing at Rye a year after the first Flemish emigrants had come to Sandwich. They came as best they could, in small sailing vessels and even in open rowing boats, in wretched condition and quite destitute of means. England received them, and the next few years saw a steady trickle of French refugees into this country until Henry of Navarre's Edict of Nantes put an end to their troubles for a short time, by granting freedom of worship to all French subjects.

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* See *The Silk Industry*, by Sir Frank Warner, K.B.E.

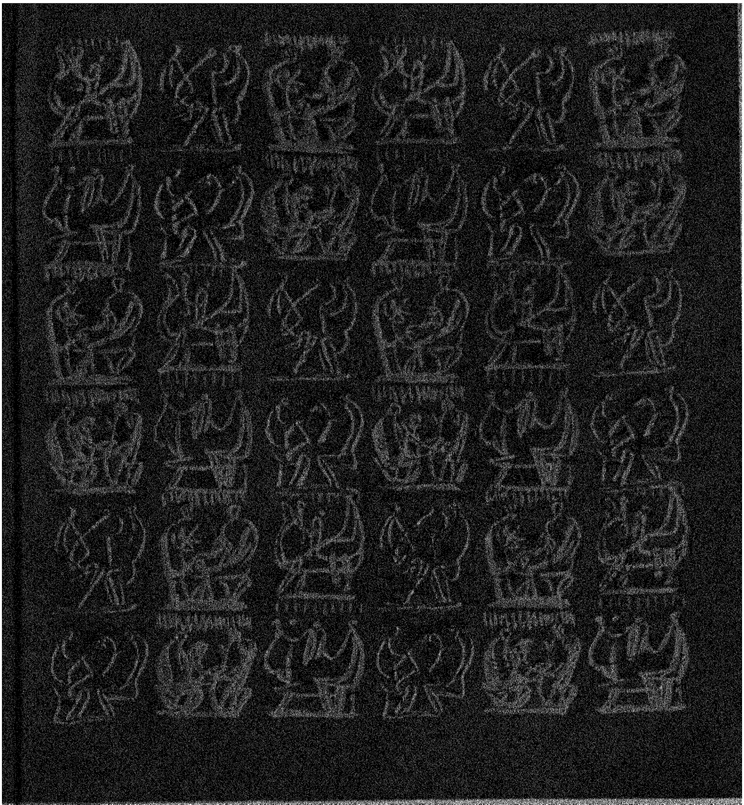
In 1685 the Edict of Nantes was revoked and this was the signal for a fresh outbreak of religious persecution; the Huguenots, (as the French Protestants were called), escaped from France in great numbers, in spite of strenuous efforts on the part of the French authorities to prevent them. Once more England became an asylum for a host of refugees, more numerous than ever this time, and who again brought their skill and knowledge to enrich our textile industry. This new wave of homeless people was made welcome, sums of money voted for their maintenance and homes found for them. Over 50,000 Huguenots escaped to England of whom some fifteen thousand were settled in London—in Spitalfields, Shoreditch, Aldgate, Bishopsgate, Long Acre, Seven Dials and Soho, whole districts becoming preponderantly French in their population. The newcomers were as industrious as their Flemish predecessors and were soon able to maintain themselves by their own efforts. Though this account of the settlement of the French refugees must lay the greatest stress on their weaving skill, it should be mentioned that, besides this, they were adept at other kinds of manufacture, such as that of combs, pins, buttons, paper of all sorts, fans and girdles, laces, gloves, and beaver hats. In fact so many French felt makers settled in England that the French felt industry completely ceased manufacture for forty years and France was obliged to buy her felt hats in England! The coming of the Huguenots was of the greatest advantage to English industry as a whole, and soon all the goods which heretofore had been imported from France, to the tune of two and a half million pounds a year, were being made in this country.

Besides the London settlements the Huguenots were also established in Norwich, Coventry, Leek, and Canterbury and in all these centres continued their silk and linen weaving. But the most famous of all the silk industries established by them was that of Spitalfields, which became very prosperous and was destined to influence the development of broad silk weaving in other parts of England: this obscure little borough was to become noted for its damasks, velvets, lutestrings, padusoys, brocades and other fine silks, which rivalled those of Tours and Lyons.

The choice of Spitalfields by the Huguenot weavers was natural

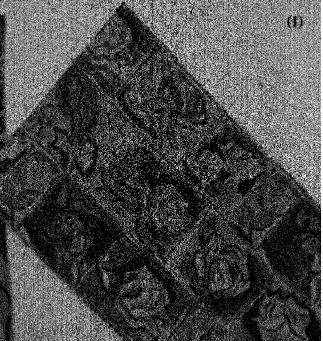
PLATE I

(1) Pure silk scarf screen-printed with a design (Family Group) by Henry Moore *Ascher (London) Limited.* (2) Screen-printed dress material. Designer, Felix Topolski. *Ascher (London) Limited.* (3) Rayon dress material printed with a design by Graham Sutherland. *Courtaulds Limited.*



(1)

(2)



(3)

enough for it had been a weavers' colony since the time of Elizabeth. There seems to have been some difficulty in housing all the newcomers; many new streets sprang up with houses specially built to meet the weavers' needs. In these houses, scattered among the winding streets and narrow alleys and courts which made up the district, the weavers both lived and worked. The lower floors were used as living quarters and the top story, insulated from the rest of the house by a double floor, was used as a weaving shed. Attracted by the district's reputation as a weaving centre and also by the fact that the greater part of the native population here was strongly non-conformist, refugees from France continued to settle in it, so that by the middle of the eighteenth century the weavers of Spitalfields were very numerous and the silk industry well established in its new home. And in the neighbouring districts were to be found the other crafts connected with silk weaving: the throwsters and the dyers, as well as the mercers who sold the finished cloth.

Most of the Spitalfields householders were master weavers who specialized in weaving their own designs; their households contained, besides their own families, numbers of apprentices and of journeymen, if the latter were unmarried. During the whole of the eighteenth century the district was busy and prosperous and its damasks and brocades were in great demand for furnishings and for fine ladies' and gentlemen's clothes, whilst its figured and cut velvets were much sought after for the most fashionable waistcoats. No capitalist manufacturer had as yet appeared upon the scene and each weaver worked for himself, supplying his goods direct to the mercer or draper, who sold them from his city shop, often ordering special materials or designs as his trade required. The weavers' colony continued to grow at such a pace that it presently overflowed into the neighbouring borough of Bethnal Green; but here the weavers were not so well housed as in Spitalfields, for though the houses built for them were still on the French plan with living quarters downstairs and a top storey weaving shed, they were badly and meanly built. From the end of the eighteenth century the weavers' prosperity began to wane, the overflow into Bethnal Green marking the first signs of this. This gradual descent into a poverty which was to become acute in the next century, was chiefly due to the great increase in the number of weavers, so that production began to outrun demand. As the nineteenth century progressed the Spitalfields and Bethnal Green weavers became more and more poverty-stricken, and their districts more overcrowded and unhealthy. The population was at its peak between 1820 and 1830 and the weavers had reached their lowest depth of degradation. By 1840 they were overflowing into the neighbouring districts, Shoreditch, Mile End Road, and Whitechapel, and here their living conditions were even worse. By the middle of the century a new phase had set in, for the number of operative weavers had greatly decreased owing to the departure of many of the younger men to the provincial silk weaving centres, where work was reputed to be more plentiful owing to the introduction of the factory system in which, if the wages were low, employment was at least steady and constant.

By that time the operative weavers no longer sold direct to the drapers but worked for rich manufacturers who gave out work to them through the medium of a system of foremen and managers; a few actual factories were also started in London, which were not very successful. But for a while, the weavers, though poor and downtrodden, did manage to keep their craft alive. The final death blow was dealt to them by the Commercial Treaty signed between this country and France in 1860, one of the terms of which allowed the duty-free import into this country of French cotton, wool and silk goods, while similar English goods were to be admitted into France at a duty of not more than thirty per cent. (The import of English textiles into France had previously been prohibited.) The effects of this treaty were immediate and disastrous to Spitalfields; many firms with hundreds of weavers on their books, to whom they were in the habit of giving out work, announced that no more such work would thenceforth be given out, as they would be able to buy more cheaply from abroad. Retail merchants also helped to spread ruin by buying up the entire stocks of French warehousemen and manufacturers for cheap re-sale in this country. Thousands of weavers were thrown out of work and many of the more reputable manufacturers were also involved in the crash, and sold to the retailers the whole of their stocks at ruinous reductions. Competition against the flow of light, cheap, and attractive goods from France was impossible and the history of Spitalfields as one of the glories of English weaving was at an end. In its heyday it produced some of the most beautiful silk materials ever woven in England, materials which greatly influenced the development of this industry elsewhere in the country. Proof of the extreme fineness of these fabrics is preserved in some beautiful samples of Spitalfields silks and velvets in the Bethnal Green Museum.

Next in importance to the Huguenot settlement in Spitalfields was that of Norwich; that these refugees should have been attracted to this town in considerable numbers was perfectly understandable, for it already had a great reputation as a cloth-making centre and, as we have seen, had already begun in some measure to make silk materials. The newcomers settled down very comfortably with their Flemish predecessors and began to make the silk materials in which they were particularly skilled: lutestrings, brocades, satins, Padua toys, watered tabinets and fine quality black and coloured velvets. The town's industrial life benefited enormously from the impetus given to it by this new settlement, and prosperity continued to increase; nearly all the inhabitants had some connection, direct or indirect, with textiles and the town also had a great reputation for the dyeing of both silk and wool. Defoe in his *Tour Through Great Britain* says: "When we come to Norfolk we see a face of diligence spread over the whole country; the vast manufactures carried on chiefly by the Norwich weavers employ all the country round in spinning yarn for them . . ."* Defoe estimates that in 1721 there were 120,000 people employed in the Norwich textile industry, not all, of course, in the city itself, but inclusive of all the country people employed by it as well. But the scene was not always a peaceful one, the city being much troubled by outbreaks of rioting, Norwich weavers having always been known as an extremely turbulent set of men. This sort of trouble continued all through the eighteenth century. But in spite of the damage and disturbance caused by the weavers' tendency to violence, the city continued its prosperous and industrious existence. From the middle of the eighteenth century the export trade was rapidly growing larger, and buyers from all over Europe were to be found in the city. In the diary of a Norwich manufacturer, dated 1751, are recorded the visits of buyers from Cadiz, Venice, Leipsig, Copenhagen, Lubeck, Amsterdam, Zurich, Frankfort, Cologne, Stockholm, Weimar, Bremen, and Christiania. Certainly the account given, in 1771, by Arthur Young, in his *Tour of Eastern England*, shows that the Norwich merchants had a very just and lively appreciation of the necessity for studying the special needs of the foreign markets: "By sending their sons to be educated in Germany, Spain, and Italy, they qualified them for the execution of their plans, and at the same time cultivated a more familiar connection with those countries. Their travellers penetrated through Europe, and their pattern cards were exhibited in every principal town from the frozen plains of Moscow to the milder climes of Lisbon, Seville, and Naples. The Russ peasant decorated himself with his sash of gaudy callimanco, and the Spanish hidalgo was sheltered under his light coat of Norwich camblet . . . The tastes of foreign nations were consulted. The loom was taught to imitate the handiworks of Flora, and the most garish assemblage of every hue satisfied the vanity of the Swabian and Bohemian female. The great fairs of Franckfort, Leipzig, and Salerno were thronged with purchasers of these commodities, which were unsuccessfully imitated by the manufacturers of Saxony. Norwich was crowded with looms . . ."*

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* See *Tour Through Great Britain*, by Daniel Defoe.

The fame of Norwich was closely bound up with the popular Norwich crape, mention of which is frequent all through the eighteenth century, especially in connection with mourning wear. This material was not a crape as we know it to-day but actually the bombazine, made of silk and worsted, which the Dutch weavers had first introduced in 1575. The Norwich crape which was to attain immense popularity and to set all the other manufacturers in the country producing imitations of it, was invented in 1819, and was also made of silk and worsted, but did not otherwise resemble the original bombazine, which had a silk warp and worsted weft and was twill woven, the worsted forming the face of the cloth. The new cloth was a tammet weave, that is, quite smooth and with both sides alike, and immediately became so popular that it almost completely swept coloured bombazines and other silk and worsted unions away from the whole range of women's dress. This new material was woven "grey," dyed to a large range of colours, and given a particularly soft and lustrous finish. On the heels of Norwich crape a whole host of lightweight silk and worsted materials were produced, which were in turn followed by the production of a cloth called "challis," which was woven like the crape but was much thinner and softer and given a dull instead of a lustrous finish. Challis was often printed with delicate sprigged floral designs and also sometimes woven with a figured pattern. It is interesting to note that though the word challis is very rarely met with in the British textile industry to-day it still remains in current use in America where it is employed to describe a material very closely resembling the original, but which seldom has any silk content.

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* Quoted in *The Silk Industry*, by Sir Frank Warner, K.B.E.

The influence which Norwich crape had on the silk industry of Essex will be described later in this Section; the Joseph Grout who first introduced it into that county was the founder of a firm which continued to manufacture materials in Norwich throughout the nineteenth century, the fortunes of which were very closely bound up with those of the town during this period, producing crape and kindred light materials. But the end of the eighteenth century marked the height of the Norwich textile industry; after that date the rivalry of the West Riding towns and the growing importance and popularity of cotton gradually ousted it from its pre-eminent position. It became more and more dependent upon its foreign trade which was to a great extent reduced by the American Civil War. A certain brief spurt of renewed popularity for a Norwich novelty which occurred during the nineteenth century is worth mentioning, not only for this reason, but also because it was made on a new type of hand loom which was the forerunner of the Jacquard loom. This novelty was a range of shawls called fillover shawls, which were first made soon after 1802. These were not the first shawls woven in Norwich, for as early as 1780 cotton had been introduced for the first time there for making some very simple shawls intended for the American export trade. These were followed by shawls made of silk and worsted, which were either in plain self-colours, or block printed with an outline design which was afterwards filled in with silk or wool embroidery. The fillover shawls which followed these could only be made on the type of loom for which a Joseph Mason had taken out a patent in the reign of James II. By the use of this loom the most elaborate multi-coloured figures could be woven at a much greater speed than by the old methods, but it also required a great deal of skill on the part of the weavers, who were highly paid for such work. The shawls fetched very high prices, twelve to twenty guineas apiece, even fifty guineas not being unusual for the more ornate kind: they were very fashionable but the trade in them was seriously injured by inferior imitations which were woven in Scotland.

Among the Huguenot refugees were to be found not only broad silk weavers but also ribbon makers; some of these craftsmen settled in Coventry where they began an industry which was to continue until the end of the nineteenth century. Coventry, in common with the rest of England, had already a long history of clothmaking; wools and worsteds at first, and silk from about the same time as this manufacture was developed in Norwich. In 1672 a Silk Weavers' Company was formed in the city, which a little later was affiliated to the worsted weavers, separating from these in 1703 to reform the Silk Company. So the Huguenot weavers found themselves in a town where silk was already an established part of industrial life. At the time of their arrival, and for the next seventy years, until the introduction of the so-called Dutch loom (see Section Six, page 76) all ribbons were made in single widths on looms called single-hand looms, so that the industry employed a very large number of people. The Dutch loom could weave several widths of ribbon at one time, but the single-hand loom continued in considerable use well into the nineteenth century. Ribbon manufacture has always been a somewhat precarious business for it is one which essentially depends upon the whims of fashion; sometimes the demand is very great, at others fashion strips ribbons from every garment and hat. So the history of this industry in Coventry is one of sudden depressions, alternating with equally sudden bursts of prosperity. It also suffered from the economic and social upheavals which the rise of machine processes brought everywhere in their train. But from the middle of the nineteenth century business became progressively worse, until ribbon making proper ceased altogether in 1903, though the weaving of other types of the narrow branch has continued in this city.

Another town where ribbon making was initiated by the Huguenots was Leek; the French settlers migrated here from Coventry and started to make ribbons and ferrets (narrow bindings). The making of silk, mohair and twist buttons was also introduced at about the same time. Many of these buttons were elaborately hand embroidered with silk and in great demand for the fashionable clothes of the period. But unlike Coventry, ribbon manufacture in Leek survived all the vicissitudes imposed by the dictatorship of fashion, and is still to-day an established part of the British textile industry. The variety and intricacy of the ribbons made here has grown steadily ever since the first figured ribbons were made in the town in 1800 and they are to-day as fine and varied as the best made on continental looms.

Another branch of silk making was introduced into Leek in 1815 which has continued in full production to our own times. This is the manufacture of sewing silks, embroidery silks, tailors' twist and sewing machine twist, braids, cords, bindings, boot-laces, all sorts of silk trimmings, mercerized cotton embroidery threads, and at the present day, scarves, handkerchiefs, woven labels and men's ties. Leek's third equally prosperous industry is concerned with silk dyeing and finishing and the printing of all sorts of dress materials.

A once prosperous silk industry which proved ephemeral was that of Canterbury. The Flemish weavers who settled in this city in the reign of Elizabeth were mostly Walloons from Lille, Turcoing, and Nurelle, and they were given the same governmental welcome and protection which had been extended to their fellow-countrymen elsewhere in England. Though they, like the weavers of Norwich, were makers of bayes, sayes, and other woollen goods, there were also among them weavers of silk as well as makers of fringe, laces, and ribbons. As usual they met with opposition, but this time it was from the weavers of London, who energetically objected to this foreign competition, an objection understandable perhaps as the Walloons were better weavers than they. They do not seem to have encountered any local opposition and the dispute was settled by an edict which bound them "to make cloths not such as the English make for the present": a good example of a truly Elizabethan compromise which evaded the difficulty and at the same time secured important benefits. The Walloons had a hall set apart for them, where their goods could be examined and sealed and they were given permission to do their own dyeing and to manage their own transport to London and elsewhere and to sell without let or hindrance. In return for these privileges various taxes were imposed upon them. By the mid-seventeenth century they had a thousand looms in operation, in 1676 (the year the London Silk Weavers' Company was formed) the number of their looms was two thousand, five hundred. The Canterbury specialities included many kinds of rich striped silks, figured materials woven with silk, gold and silver threads, and mixtures of wool and silk. At the end of the seventeenth century the industry was at its zenith but from this time, in spite of repeated efforts to save it, it continued to decline. Many of the weavers, amongst them some of the more recently arrived Huguenots, left Canterbury and settled in Spitalfields. The cause of this decline was the importation of cheaper Oriental silks, for Canterbury silks were dear, some of them fetching as much as ten or twenty shillings a yard. A few weavers remained in the city and work lingered on in a desultory way until as late as 1886; at this date there were only two hundred looms in the city and even these were derelict by the end of the century, most of the handful of weavers having died, and the once thriving industry no more than a local tradition. A gallant attempt to revive it was made by two Canterbury ladies in 1896; but though some beautiful silks were made the experiment never took firm root and came to an end soon after the accession of Edward VII.

We now come to the establishment of silk manufacture in two widely separated areas: Macclesfield in Cheshire, and in Essex. The picture here is a bright one for all these industries have continued in unbroken production since their foundation, and three of them are to-day the most important and thriving centres of silk weaving in the country; Macclesfield being known for its beautiful dress materials and Braintree in Essex for its sumptuous silk furnishings, high grade dress goods and special ecclesiastical cloths; Bocking in Essex is a great centre of the rayon industry which has grown here naturally from an already firmly established silk manufacture.

"Macclesfield silk" are household words to every woman in the British Isles and though a great variety of materials are made in this town, the name Macclesfield immediately summons up a picture of its great speciality: soft handled, hard-wearing silks woven in a wide range of multi-coloured stripes. It is not easy to understand why silk should have become so firmly established here or why it did not succumb to the same vicissitudes as those which ruined Spitalfields. Perhaps one reason is that broad weaving started much later here, perhaps its originators were better business men than the Spitalfields weavers and were able to profit by the lessons that the decline of the latter had to teach. Also silk was no new thing in Macclesfield when actual weaving began, for silk button making had been carried out in the town since the late sixteenth century and was still active when the first silk throwing mill was set up in 1756 by Charles Roe, who had been a button manufacturer since 1740. A number of other throwing mills were soon built and successfully operated, and for the next thirty years these, and Roe's original mill, were fully occupied in making yarn for other parts of the country, the chief outlet being London, which bought for the Spitalfields weavers; a good sale for twists and sewing silks also continued. Broad silk weaving in Macclesfield began somewhere about 1790 and continued at a steady pace until early in the nineteenth century, when the fairly highly paid weavers found themselves obliged to accept a reduction in their wages of twenty-five per cent, owing to increasing competition from the distressed weavers of the adjoining county of Lancashire. (In 1824 conditions in Lancashire led to riots which were serious enough to cause the authorities to call out the military.)

But the set-back was temporary, for in 1824 the duties on the import of raw and waste silk were reduced and the Macclesfield manufacturers were quick to make use of this to extend their business. Advertisements for weavers and throwsters appeared in the local press which offered employment to four to five thousand people. The age limits set out in these advertisements throw a grim light on working conditions at this time, these being set out as "persons from seven to twenty years."* The next few years brought more riots and in 1829 there was a prolonged weavers' strike which caused serious distress amongst the working classes, a special grant of £1,000 being made by the King for their relief. High wages have always been maintained in Macclesfield, though often at the cost of loss of business to other centres. During the difficult middle years of the nineteenth century the concentration of the town's industry on the export trade in bandanna handkerchiefs stabilized its condition, and though it was hard hit by the Commercial Treaty of 1860 with France, it was able to weather the storm. Macclesfield manufacturers have always been progressive and this town, from the very first, made full use of all the inventions and improvements in machine production which the industrial revolution of the late eighteenth and early nineteenth centuries brought with it. To-day it continues its manufacture of all kinds of dress goods such as foulards, crapes, satins, moirettes, silk and wool and other union cloths, its own classic stripes and also of rayons. To these have also been added tie silks, scarves, handkerchiefs and a prosperous trade in women's made-up garments and knit-wear. Silk throwing and the manufacture of yarns, thread, gimps, braids and trimmings also continues and there is a good local industry for the processes auxiliary to silk making, such as finishing, dyeing and printing.

The county of Essex has had a long connection with silk manufacture, the first record of this referring to one Paul Fox, who was a silk weaver in Plaistow in 1645. Silk throwing was a minor industry in the county from the year 1718 when such mills began operation both at Little Hallingbury and Sewardston, Waltham Abbey. The Little Hallingbury mill is notable for the fact that it had an installation of the new type of throwing machinery which had been introduced into England by John Lombe of Derby, on his return from Italy. (See Section Six, page 77.) During the first twenty-five years of the eighteenth century a great many silk mills, both for throwing and weaving, were established at various points in Essex: at Harlow, Saffron Walden, Halstead, Coggeshall, Bocking, Braintree, Colchester, Malden, Billericay, Chelmsford, East Ham, and Stratford. The greater part of these ventures were short lived, though some continued until the late eighteen sixties. But out of all these early local industries the twin towns of Bocking and Braintree were the only ones to continue operations until our own times. To-day they are still two of the most important of all British silk centres.

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* See *The Silk Industry*, by Sir Frank Warner, K.B.E.

The real history of silk in this county may be said to start in 1798 when George Courtauld (ancestor of the famous modern silk and rayon family), set up a throwing mill at Pebmarsh. He was a great grandson of a Huguenot refugee who settled in England somewhere about 1686 and was the first of his family to have any direct association with silk manufacture, having been apprenticed to a silk throwster in London in his youth and having, for some time after, worked at this craft on his own account. He spent some years in America and returned to this country in 1794 to act as assistant to a Mr. Noailles, a silk manufacturer of Sevenoaks in Kent. This connection was severed after three years, owing to political differences, and after an abortive year spent in paper making in London, George Courtauld set up a silk throwing mill at Pebmarsh in Essex, in partnership with a Mr. Witt, building a new mill as well as cottages and houses for his workpeople. He continued at Pebmarsh until 1809 when he was approached by a firm of Cheapside silk manufacturers and asked to set up a silk throwing business on a larger scale than any he had as yet ventured upon. The agreement was that George Courtauld was to be manager and ultimately to be taken into partnership. On his recommendation the new works were established at Braintree in 1810, on the site of an old flour mill which was demolished for this purpose; the fall of water was diverted to supply power and new machinery installed. Courtauld continued as manager, although the business was carried out in his name, until 1814 when he was made a partner in the firm. Two years after this the partners quarrelled over the price scale and all work at the mill was stopped, Courtauld finding himself faced, not only with the cost of maintaining thirty apprentices, but with having to dismiss operatives and cause great local distress. A lawsuit resulted, which was concluded in Courtauld's favour in 1817. Never very happy in England, owing to his advanced Liberal opinions, he returned to America where he died in 1823.

Owing to the Napoleonic wars, there was widespread distress in the agricultural areas and the existence, therefore, of a good source of labour upon which to draw may have been one of the reasons for which Pebmarsh and later Braintree were chosen for the new mills; other considerations were probably that these places were about midway between the silk centres of London and Norwich, and that ample water power was available. There was also a long established clothmaking tradition in this countryside, where woollen cloths had been made since before the fourteenth century; Bocking, where the next Courtauld business was to be set up, having long been famous for a special kind of cloth known as "Bockinge." This new Bocking venture was initiated by George's son Samuel in 1816, before his father's lawsuit was settled. In 1819 Samuel Courtauld bought up an old baize mill, also at Bocking, and transferred all work and machinery to this. At this time, and for some time longer, silk throwing was the only form of manufacture carried out by him.

We have seen how the new type of silk and worsted material called Norwich crape leapt into popularity, and manufacturers all over the country began to imitate it. A further impetus to the production of this material was given by the order for Court mourning issued by the Lord Chamberlain on the death of the Queen in 1818; this stipulated "The ladies to wear black bombazines, plain muslins or long lawn linen, crape hoods, shamoy shoes and gloves and crape fans. Undress; dark Norwich crape." About 1819 manufacture of crape was begun at Saffron Walden by Joseph Grout, a native of the place, who had been engaged for some time in silk manufacture in Norwich. This crape making was very successful and in 1822 Grout's firm took out a patent for a new process in connection with it: the embossing of a plain crape with various patterns. (For a description of this process see Section Twelve, page 152.) This embossed crape was the first real mourning crape such as is still made to-day. By 1825 the Courtauld mill had also begun to make this mourning crape, a material which was to become the foundation of the firm's prosperity and to form a large part of their manufacture from that day to this. The first crapes made by Courtauld were hand woven and generally given out to the local weavers to make on their own looms. (On the whole the silk industry was slow in adopting power weaving and this, at first, was only used for the coarser types of material.) Courtauld's new manufacture was successful and by 1845 the firm were also making velvets and satins. Some years before this they had built a new finishing building and a new dye house was added in 1828. The firm's first power-loom factory was built soon after this and extended in the years 1836 and 1842.

The silk industry in Essex prospered as a whole until the signature of the French Commercial Treaty in 1860. This treaty, which was fatal to many branches of the English silk weaving industry, also inflicted a heavy blow to the Essex manufacture and was the cause of the decay and final cessation of it in several parts of the county. The exceptions to this were the Bocking and Braintree branches; both towns had been fortunate in concentrating early on specialities, rather than on general trade, and for this reason were able to surmount the difficulties to which the greater part of the rest of the county's silk manufacture succumbed. From this time the two towns became the acknowledged leaders in Great Britain of their own particular branches of manufacture, and the history of Essex silk virtually becomes that of two great firms, known to-day as Courtaulds Ltd., and Warner and Sons, Ltd.

Courtaulds laid the foundations of their business by the manufacture of mourning crape and they also improved the mechanical processes by which this material is given its characteristic figure. In the Great Exhibition of 1851 they exhibited a variety of such crapes as well as a new thin, solid coloured silk gauze, which they named aerophane. The founders of the firm had been strongly Liberal in principle, and also had family affiliations with America, so that it is not surprising to find them at this time staunch supporters of Free Trade, and also very well aware of the importance of the overseas markets. By 1860 the firm was employing about 2,500 people and had a wage sheet of over £100,000 a year. An idea of their expansion can be gathered from the following figures:*

	Packets of Finished Crape.	*Packets of Fancies Finished.*
1829–1841	69,191	No figure.
1842–1851	224,171	6,300
1852–1861	279,605	14,700

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* From *A History of Courtaulds*, by C. H. Ward-Jackson.

Courtaulds survived the disaster of the treaty of 1860, thanks to their secret process for the making of mourning crape, a material which the French could not make, and indeed, the treaty brought them some advantage as it ended the prohibition on the import of English silks to that country, so that France became an important market for Courtaulds crape. At home the trade in this was also increasing, for the Prince Consort's death and the Queen's long enduring mourning set an unprecedented public fashion for plunging into the deepest mourning at the slightest bereavement. Once again public events increased the firm's prosperity, for the Franco-Prussian war brought an increasing demand for mourning crape. From this time until the early eighties the firm, though making other silks, was chiefly known for its crapes; at the end of the eighties another phase of manufacture began. The fashion for the extreme of mourning was dying out and there began to be an appreciable falling off in the demand for crape. This situation was promptly met by Courtaulds who began in 1889 to make a whole new series of light fancy dress materials called *crêpe Italien, crêpe de Pekin, crêpe Espagnol, crêpe Indien* and *crêpe de Chine.* Like most fashion names for fabrics many of these names were ephemeral and are obsolete to-day, with the exception of *crêpe de Chine* which has become a classic of women's wear. The production of these new cloths was accompanied by a reorganization of the firm which became a private company, the objects of which were the manufacture of crape, silk, wool, cotton, "and other fibrous substances of all kinds." At about the same time it first seriously turned its attention towards the possibilities of the new so-called "artificial silks." It continued to manufacture all sorts of light-weight gauzy fabrics, as well as *crêpe de Chine*, and the demand for these increased at such a rate that at the beginning of the twentieth century Courtaulds were absorbing about twenty-five per cent of England's total imports of raw silk. But mourning crape still continued as the firm's chief product, having by this time been greatly improved in handle and suppleness, as well as being made water-proof. From the beginning of the new century the firm, though still actively manufacturing silk, became increasingly concerned with the development of rayon, and this aspect will be dealt with in the Section devoted to this material.

In 1826 a firm was founded in Braintree which made a very considerable reputation for the manufacture of fine furnishing silks. This was the firm of Daniel Walters and Son, and thanks to its specialized manufacture it was still active in 1861 despite the French treaty; at this date it had some hundred and fifty Jacquard looms and three hundred employees, its specialities being the finest of brocatelles, damasks and tissued satins. It went into liquidation in the late seventies and its goodwill, plant and designs were bought up by what was then known as the firm of Warner and Ramm, this being the firm's first association with silk manufacture in Essex. Warner and Ramm's were founded by Benjamin Warner in 1870 and had its first workshops in Old Ford in London, where it carried on business as fine hand-loom silk weavers. In the year 1892 Mr. Ramm retired and Benjamin Warner's two sons, Alfred and Frank, who had received their technical education in Lyons, were taken into partnership and the firm's name was changed to Warner and Sons Ltd. Larger factories were built in Bethnal Green, and later the whole of the firm's work was transferred to still larger factories at Braintree, where it is still in active production and acknowledged as leader in its own special branches: the finest silk and rayon furnishings, plain and figured silk dress materials and ecclesiastical cloths.

In 1901 Warner's established a cottage industry at Sudbury for hand-loom weaving of velvets but much of this work has since been transferred to Braintree. They also successfully revived the richly figured velvets for which Genoa was once unrivalled. Warner's have always been outstanding for the meticulous care which they have given to the question of design; many of the firm's most beautiful cloths have been designed in their own studios and show the excellent results which can be obtained by the co-operation of designer and technical staff, working in close harmony together. To-day the firm has added the weaving of rayon and of other fibres to its original silk manufacture, and employs both power looms and hand looms for the finer qualities. They are also actively engaged in the finer branches of textile printing.

SECTION FOUR

THE BEGINNINGS IN SCOTLAND AND IRELAND

Small importance of linen in England—early Scottish textiles—settlement of Flemish weavers from Norwich in Edinburgh—protective legislative measures—Board of manufacturers for Scotland—early Scottish silk—Scottish wool—early Irish textiles—settlement of Dutch weavers in Ireland by the Earl of Strafford—Louis Crommelin—rise of the Irish linen industry—Board of Trustees of The Linen and Hempen Manufacture—Huguenot settlers in Dublin—the Dublin silk industry—Irish wool

THOUGH THE ART of weaving linen in England is as old as that of weaving wool, it has never been a serious rival. Flax would seem to be indigenous to this country and it is supposed to have been spun and woven here, even before the Roman invasion; mention of linen occurs in old chronicles of the Anglo-Saxon period as well as after the Norman invasion. But though a certain amount of flax was grown in this country, and its fibres woven into material from a very early date, only the coarser and heavier types seem to have been manufactured, and the wearing of native-woven linen was confined to the lower classes, that worn by the nobles and richer people being imported from France or the Low Countries. Flax is included among the tithable crops as early as 1175, so that presumably a reasonable amount of it was being grown, and linen weaving would seem to have been introduced into Wales at about the same time.

But it cannot be said that linen weaving ever assumed the status of a major industry in this country, either at this or at a later date. True, some of the Flemings who settled in London at the invitation of Edward III, were linen weavers, but they met with so much opposition from the Weavers Company that they barely managed to exist and seem to have exerted no influence whatever on English linen weaving. There is very little mention of linen for the next few hundred years until we come to an Act passed in 1531 which ordered that for every sixty acres of tillage one rood should be sown with flax or hemp; this was probably due to the fact that there were some linen weavers among the Flemings who settled in Norwich at this date. Indeed, a further Act, passed in 1552, confined the weaving of "dornocks," a course diaper woven linen, to Norwich and the corporate and market towns of Norfolk. But linen was still a small and negligible part of English textiles, nearly the whole of the fine linens used in the country being imported from abroad. Repeated attempts were made to encourage the growing of flax, but these met with little or no success. It was as if the whole idea of national prosperity was so bound up with wool that there existed a jealousy of other fibres. Despite the fact that flax is a crop very suitable for the English climate and soil and that a much smaller acreage is needed to produce the same quantity of flax as of wool, it remained foreign to the English textile genius and with the coming of cotton it finally relapsed into obscurity. The prohibition on all imports of cotton which was enforced during the American Civil War gave linen making a slight impetus in England during this time; the return of cotton restored it to its original lowly place.

This is a convenient point at which to leave the English textile industry, in order to trace the origins of clothmaking in Ireland and Scotland. The later history of the industry in both these countries will be found in Section Eight, which deals with the period which begins with the opening of the nineteenth century and ends in our own day. From the beginning of this period textiles in these islands can be classified together as British, though still retaining their own regional characteristics and special branches. But until the introduction of the new textile machinery which revolutionized the whole industry, the regional aspects were paramount everywhere, and it is more convenient to continue such a classification in dealing with the various aspects of the industry in these two sections of the British Isles. The origins of Welsh textiles have already been touched upon in an earlier part of this book, and as the rise of these to an industry dates from the introduction of the new machinery, this also will be dealt with in Section Eight.

Wool has always been the fibre with which Scottish textiles have had the greatest natural affinity, and for which they are most famous to-day, but linen has also played an important part in this country, and silk a minor one. The early history of clothmaking in Scotland is that of a craft, not an industry, which produced goods of the simplest kind for its makers' needs only. Not until the twelfth century when King David, who had been brought up at the Court of England, came to the throne, did these local crafts begin to coalesce in some degree into industrial form. David introduced many southern manufactures into his kingdom, settling various artificers there to instruct his subjects in these new arts. Clothmaking seems to have advanced at a very good pace, for when in 1410 Sir Robert Umfraville, Vice-Admiral of England, raided the Firth of Forth with ten ships, he carried off such an amount of plundered wool and linen materials, that the release of these on the English market considerably reduced the prices there. For this exploit he was nicknamed Robin Mend-Market. At the Battle of Bannockburn, the carters, women, wainmen, and lackeys are said to have covered their clothes with "shirts, smocks, and other white linens . . . and bound napkins to their spears, staves, etc. and making a great show, they came down the hillside in face of the enemy with much noise and clamour." The story goes on to explain that this linen disguise persuaded the English that reinforcements had arrived, whereupon they turned and fled. From all accounts Scotland seems to have taken much more kindly to the manufacture of linen than England, and linen attained the status of an industry here, albeit a small one, sooner than did wool, which continued as a local manufacture, chiefly home consumed, until the introduction of the weaving machinery of the eighteenth and nineteenth centuries. Linen, too, was largely a domestic manufacture, and as hard cash has never been too plentiful in the Northern Kingdom, it is often found among payments in kind, instead of in money, made by country people to a landlord. For instance, there is an entry, dated 1600, in the Marquis of Huntley's rent roll which notes the payment of 990 ells of "custom linen." Linen also seems to have been exported from Scotland during the sixteenth century.

Seeing the prosperity which the textile industry was bringing to England, the Scottish authorities were anxious to foster it in their own country and with this end in view a small body of the Flemish weavers from Norwich were invited in 1587 to settle in Edinburgh. By the Act which was passed to regularize the position of the strangers, they were bound to remain in Scotland for at least five years, and to bring with them a body of thirty craftsmen, to be made up of weavers, finishers, and dyers. They were also to be entirely responsible for their own people and not to suffer these to beg or to "trouble this cuntrie with povertie." This first Flemish settlement was followed by another in 1601. The Flemings were enjoined to take Scottish boy and girl apprentices, and to give preference to Edinburgh children for this. The Flemings, besides making serges and bayes were to initiate the weaving of worsted and to teach the weaving of broadcloth; whether there were also linen weavers among their number or not, linen weaving became from this time regularized as a manufacture instead of a cottage industry; but through the whole of the seventeenth century it was too beset by material difficulties to make much headway. The Government passed many legislative measures intended to foster the new industry, but these did not always have the desired effect. One of these measures was the prohibition of the import of English woollen goods into Scotland, which was intended to help the linen manufacture. The result was a complete reversal of the intention, the English retaliating by making the selling of Scottish linen in England a criminal offence, punishable by whipping and imprisonment. At this date, 1684, there were some ten to twelve thousand people occupied in linen weaving in Scotland, who had been accustomed to a free export to England of their goods, and who suffered severely from this retaliatory English measure. Another Scottish Act destined to encourage linen enjoined that "no corpse of any person whatsoever be buried in any shirt, sheet, or anything else, except in plain linen," and the surviving relatives were obliged to declare upon oath that they had conformed with this law. In fact, not one, but three successive Acts to this effect were passed! But Scottish linen manufacture really first began to taste prosperity after the Union with England in 1707, which brought with it a removal of the English duties upon Scots linen, which was immediately followed by a great increase of this manufacture. English manufacture of fine damask and sailcloth was initiated in Scotland; and the export of linen materials from Scottish ports to the American colonies, was begun. By 1710 the quantity of linen made in Scotland was 1,500,000 yards annually.*

In 1727 a Board of Manufactures for Scotland was established, which for the first three years of its existence controlled the disposal of funds of £6,000 a year which were allocated to the encouragement of various Scottish industries, £2,500 being devoted to the herring fisheries and linen. The money spent on linen included premiums for the growing of hemp and flax, prizes to housewives for the best woven linen, the encouragement of spinning schools for children, procuring models of the best looms, and—expenses for prosecutions! The Board also brought over from St. Quentin in France, Nicholas D'assaiville, a cambric weaver, and ten other experienced weavers and their families to teach their methods to the local weavers. At this time linen making was scattered all over Scotland, but a great proportion of the manufacture was concentrated in a band stretching across Scotland from Lanarkshire to Forfarshire—Forfarshire being the greatest producer.

The Board continued its activities, as far as linen was concerned, until 1823, and during that time the linen manufacture of Scotland continued, though retarded somewhat by the rise of cotton. Even so, though the linen industry suffered from this, it was not, as in England, reduced to a completely minor position, and later regained a solid place in the industry of the country, if not a comparable one to that ultimately attained by the Scottish woollen trade.

The manufacture of silk in Scotland was of much lesser importance than that of linen, and though silk materials are often mentioned in old documents, there is no evidence that these were made in Scotland, though the legislative measures prohibiting the importation of certain goods specifically included silk as well as wool. The inclusion of this material in such prohibitions was probably for economic reasons rather than as a protective measure for home manufacture. In 1698 the Privy Council granted the petition of Joseph Ormiestoun and William Elliot that they might be allowed to set up a silk throwing, winding and dyeing business, and this venture seems to have prospered, at least well enough to call forth complaints from the Cloth Companies that it was a manufacture very detrimental to them. While the scope of this book does not include knitwear or hosiery, it is interesting to note that there was in the last years of the seventeenth century, quite a flourishing small manufacture of silk stockings in Scotland. The first manufacture of silk which had any importance took place in Paisley, and was begun by Humphrey Fulton (born 1713, died 1779). Fulton began life as a packman, and worked as one both in England and Scotland; he then settled down to making linen in Beith and from there went in 1749 to Paisley, where he started the manufacture of silk gauze of the type then made in Spitalfields. He was successful from the first, labour being cheap and his materials both good and less expensive than the London ones; he ultimately had as many as six hundred looms in operation. So successful, indeed, were the Paisley gauzes that they were sold all over England as well as in London, Dublin, and even in Paris. Other manufactories were also established in the town, there being eighteen altogether by 1780, six of which were London firms that had migrated to the North. At the same time, lawn making continued alongside that of silk gauze, ten thousand people being engaged in the various branches of these manufactures in 1784. The later history of Paisley and its famous shawls is described in Section Eight. There were other small silk-making centres in Scotland besides Paisley, but none to rank with it in importance. In Edinburgh, for instance, there were ninety silk looms in operation by the end of the eighteenth century, and there was also a certain amount of silk throwing and winding in various places. But Paisley remains as the one great commercial success in Scottish silk manufacture.

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* See *Linen*, by Alfred S. Moore.

The history of the Scottish woollen industry is at the same time both older and more recent than that of either Scottish silk or linen; older, because Scotland has always been a sheep country and from time immemorial its people have carded, spun and woven wool—more recent, because it is only since the coming of the new textile machinery that it has emerged from the status of a peasant craft to that of a great and important industry. It is natural that woollens should have reached such a state of perfection in this country—the climate is an ideal textile one with its humid air, clear soft water and small range of temperatures, and some of the finest wool in the world is grown on Scottish sheep. For instance, the qualities of Shetland wool, with its mixture of fine, long and short fibres mixed throughout the whole fleece, and its incredibly soft, silky handle, are unlike those of any wool produced elsewhere in the world. The long history of these hand-made materials has strongly influenced the quality and integrity of the machine-produced materials of to-day. Lastly, the soft, rich colours so characteristic of these woollens are still greatly influenced by the natural, indigenous dyes used in the older craft, where alder tree bark and dockwood were used for black; currant bush tops and alum, blueberries, dulse, and crotal for brown, cup moss for purple; dandelions for magenta; blaeberries and alum, mixed with club moss for blues; wild cress for violet; whin, gorse bark, broom and knapweed for greens; bracken and heather for yellow; and white crotal for red. Not only have these natural colours influenced those of the machine-made fabrics, but they are still used for the wonderful hand-made woollens which are in such demand to-day, real Harris tweed owing its characteristic smell to the crotal used for dyeing it. The beginnings of the Scottish woollen industry are lost in the beginnings of Scottish history, its growth has been long, and slow, broken by wars and ghastly heart-breaking upheavals, like the conversion of whole districts to cultivation and sheep-rearing, which culminated in the Sutherland Clearances and sent thousands of Scots into the bitterness of exile. But it has continued because it has been a part of the people's life.

In Ireland, as in Scotland, clothmaking is deeply rooted in the history of the people, and spinning and weaving have been a part of their lives for as long as any records exist. While the soft, hand-woven Irish tweeds have great merit and are justly famous, it is in the weaving of linen that Ireland excels and for which it is unrivalled. Several things have contributed to this development of linen: Ireland is pre-eminently an agricultural country, with its agriculture almost entirely based on a system of smallholdings, and flax is a crop very easily managed by a crofter and his family, from its actual cultivation, through the various preparatory stages such as pulling, retting, and scutching, to the actual spinning and weaving which for so long have been a major occupation of Irish cottage women. Then, too, the Irish climate is especially suitable for the spinning and weaving of flax, both these processes needing a very considerable degree of humidity, and it is also perfect for the natural processes of bleaching which, even to-day, produce the best results. For linen bleaching the purest and softest of water and mild, dirt-free air are imperative, and both of these requirements are found in Ireland, where, moreover, the small range of climatic variations and the extremely rare incidence of frost or snow, always valuable factors in any cloth manufacture, are especially so in the case of linen.

It is uncertain when the actual manufacture of linen began in Ireland as there are no reliable records as to this, though the ancient Irish are reputed to have worn linen which was dyed bright yellow. Irish linen is mentioned as being in use in Winchester in the reign of Henry III, but there is no further evidence as to its manufacture before 1636 when Dutch farmers and weavers were brought to Ireland by the Earl of Strafford who, at that time, was Lord Deputy of Ireland. Though his motives for doing this seem to have been more concerned with destroying the Irish wool trade (as a potential rival to that of England) by encouraging that of linen, and his methods were so ruthless as to plunge the whole of Ireland into seething unrest, he is by some historians regarded as the founder of the Irish linen industry. Certainly the beginnings of the organization of linen making into some sort of industrial shape date from approximately this period, but its real foundations were laid later by Huguenot refugees at the end of the seventeenth century, and these were consolidated by Louis Crommelin. From the time when Strafford first forcefully urged on linen making, the English authorities, jealous for their growing wool manufacture, continued to foster the growth of Irish linen at the expense of Irish woollens. This fostering often took restrictive legislative forms, such as the prohibition of exports of Irish woollen cloths to any country except England, in the reign of Charles II; later, under William III, an Act was passed which permitted the duty free import of Irish hemp, flax, linen yarn, and woven linen into England.

Even before the Revocation of the Edict of Nantes, a few Huguenot refugees had found their way to Ireland and after the Revocation, these were joined by others; some settled in Dublin where they set up as silk weavers, others established themselves at Lis-Na-Garvagh near Belfast (now called Lisburn). The settlers at Lis-Na-Garvagh also attempted to introduce silk weaving but were not very successful in this, whereas the Dublin refugees succeeded in founding a real silk industry, which continues, in some degree, to this day. The failure with silk of the refugees in the North was, however, more than offset by the success which attended them as linen weavers, the times being particularly propitious to this craft, as the import into Ireland of French linens and cambrics had recently been prohibited with a consequent considerable increase in the demand for home-made materials of this kind. A little later, these first-comers were joined by Louis Crommelin and twenty-five other Huguenot families who had been settled in Holland, and were invited to Ireland by the Prince of Orange. Crommelin's family were originally linen weavers from Picardy. The terms upon which Crommelin was invited to Ireland are interesting, for he came, not as a penniless refugee, but as a business man with capital to invest in his new venture. The patent granted to him by William of Orange allowed for an annual payment of £800 a year for ten years, as eight per cent interest on the sum of £10,000 which he had advanced for making a bleach yard, holding a pressing house, cultivating and weaving flax and hemp, and making provision for both to be sold ready prepared to the spinners at reasonable rates and upon credit. He was also to provide all tools and utensils, looms and spinning wheels, to be furnished at the cost of the persons to be employed. Advances were to be made to them in this respect, and repaid in small sums as they were able. He was also to advance subsistence allowances to the weavers and their families from abroad, such advances to be repaid in instalments, without interest. In return for all this, Crommelin was to be personally allowed the sum of £200 a year, together with £120 for three assistants, as well as £60 a year with which to maintain a French clergyman. Not only were the terms of this grant far from attractive, but on the accession of Anne to the throne, payment of the annual grants was repudiated by the Treasury. No excuse can be found for such a breach of faith, for the £800 a year was in no sense a pension, but interest on money invested in a national undertaking by Crommelin, and the other sums involved were a small enough return for the immense value of the work carried out by him.

Crommelin was not only a business man, but an excellent organizer, and a man well aware of the importance of new methods of production. He made two great alterations in Irish methods, first by introducing the spinning wheel, hitherto unknown in Ireland, only distaff and spindle being in use, and secondly by installing numbers of Dutch looms, much superior to those in use in the country before. The spinning wheels immensely improved the quality of the yarn produced, and another innovation introduced by him also bettered the quality of the woven linen. This was the reel for measuring yarn, which till then had been prepared as hanks or cuts by rough and ready rule of thumb methods. Crommelin, in his capacity of "Director of Linen Manufactory" not only organized, supervised and inspired the spinning and weaving of flax, but opened bleaching works at Hilden to teach improved methods for this process. In addition to this, he travelled the country and taught the farmers better methods of cultivating and harvesting flax. Altogether he seems to have been a most remarkable man, with unbounding energy and real creative and administrative abilities. To him, in no small measure, Ulster owes the position which it holds to-day as leader in the manufacture of linen.

In 1711, a Board of Trustees of The Linen and Hempen Manufacture was established, and it is somewhat ironical to find that, whereas the Treasury repudiated the grants to Crommelin, this new body was given a grant of £20,000 annually. But though the treatment of Crommelin was ungrateful to a degree, it is at least satisfactory to know that the work which he began was worthily continued by this Board, and that excellent use was made of the much increased Government funds put at their disposal. The expenditure of these funds was practical and progressive, and did much to encourage the industry. The Board continued the provision of spinning wheels and better looms, begun by Crommelin, and paid bounties both to encourage the growing of flax and the weaving of the finer and better types of cloth, the grant being generally about equally divided between encouragement of flax growing and of linen weaving. Another of the Board's activities was the standardization of the length and breadth of all cloths woven, as well as fixing standards for evenness of texture throughout an entire web. No linen might be sold unless it carried the seal of the Board, and its officials attended all the country fairs to examine and seal the goods exposed for sale. It is not to be supposed that the easy-going Irish always took kindly to these controls, and there were various outbreaks of trouble over their enforcement, particularly at Dromore where the trouble was sufficiently serious to receive the name of the Linen Riots. But things settled down, the weavers ultimately realizing the benefits which the Board was conferring on their industry. By 1826 the Government felt that the Board's work was nearly done, and that the Irish linen industry was sufficiently thriving to stand on its own feet, so in this year the grant was reduced to £10,000, and notice given that it would shortly cease altogether. This it did in 1828, and the Board came to an end. That its work was well and vigorously done is proved by the growth of the industry all through the eighteenth century. In 1710, the year before the Board was established, Irish linen exports were 1,688,574 yards; in 1800 the figure was 34,563,868 yards, while in 1825 it was 55,113,265 yards. This constant increase is all the more interesting when it is remembered that during the whole hundred and thirty years during which the Board functioned, linen spinning and weaving was entirely a cottage industry, and therefore liable to constant interruption, as the weaver and his family carried out the other work needful to running their farm. For not only did the farmer and his family spin and weave the flax, they also grew and prepared it, and very often bleached it as well.

The linen was sold either brown or bleached, to a draper who sold it locally or at the Dublin Linen Hall, or later at the Belfast Linen Hall, which became the centre of the trade in 1783. The linen sold in these halls was bought by merchant exporters. The year which saw the cessation of the Linen Board also saw the introduction of the first power-driven machinery for linen in Ireland. This was machinery for the spinning of flax, and it was introduced into Belfast by the firm of Mulholland, who were later known as the York Street Flax Spinning Co. Ltd., and who, under that name, are still one of the greatest manufacturers in Ulster, both of linen yarns and threads of all kinds, and fine household linens and handkerchiefs.

Earlier in this Section, mention was made of the Huguenots who began a silk industry in Dublin, and we must now return to them. These Huguenots were made very welcome in Dublin, and everything possible done to encourage them to settle in that city, even to admitting them to the city gilds without payment. The Huguenots set up their first silk looms in Dublin in 1693, and as usual with them, and as was also the custom in Ireland, the weavers worked in their own homes, a part of the city known as the Earl of Meath's Liberties being the district in which the greater part of the weavers' settlement took place. As usual with the Huguenots, silk button makers as well as weavers were amongst their number, and in 1707 a Petition was presented to the House of Commons by Dublin manufacturers of silk and mohair buttons, complaining that their trade was being injured by the rivalry of horn, cloth, and wood buttons, and demanding that this rival manufacture should be suppressed.

The skill and industry of the French weavers brought them success for the first few years, and by 1730 there were eight hundred looms in the city, all engaged in making silk dress cloths. At this time tabinet or, to give it the name by which it was to become famous, Irish poplin, was already being made. As usual, all sorts of restrictive legislature was enacted to protect the young industry, and heavy duties imposed on the imports of any material which could enter into rivalry with its products. The duties on Eastern, French, and Italian silks were, in fact, so heavy as to give rise to a great deal of smuggling, such goods being brought in *via* England, where the duties were much lower. But in spite of all these measures and though the duty on foreign silk had risen to as much as £4 a pound, the industry languished. In 1763 the Corporation of Weavers petitioned Parliament for help, stating that where there had been in 1731 eight hundred looms at work in the city, there were now only fifty, and many families "were reduced to beggary." In this year the Irish Parliament made a grant of £8,000, "for the encouragement of industries" to the Dublin Society, silk being specified as the first to be helped. Under the stimulus of subsidies paid from this grant in the form of ten per cent payments on all Irish silks sold in a public warehouse, and of exhibitions and prizes, the industry began a spurious upward trend. One of the means chosen to help the industry was a forerunner of the modern fashion stylist, for a Committee of Lady Patronesses was set up to advise the manufacturers on questions of fashion. For twenty-two years this artificial stimulus was applied to the trade, which on paper had the appearance of being in a highly prosperous condition, the number of looms in operation sometimes rising to three thousand. But the prosperity was entirely fictitious and only due to the industry's highly protected and subsidized condition. In 1785, after £28,000 had been spent in trying to get the industry well and truly established, the effort was abandoned, as the plan "had not answered the ends of a general increase and extension of the manufacture."*

The Dublin weavers were in a bad way, and though a tariff on silk goods, which was imposed at the time of the Union in 1800, did a little to improve matters, the effect of this was later stultified by the abolition of all duties on silk imports in 1826.

The Irish wool industry continued for a very long time as two separate branches: the foreign export branch for woollen yarns and a small localized industry of rough woollen cloths such as frieze. The reasons for this are entirely attributable to the English woollen cloth industry. As this expanded, Ireland became a valuable source of supply for yarns and, as we have seen, the English Government pursued a consistent policy of encouragement to the Irish linen industry at the expense of the woollen, largely with a view to protecting its own woollen manufactures. It is only in comparatively recent times that Irish woollen materials have come into their own elsewhere in the world; to-day the beautiful hand-woven Donegal tweeds, and the excellent woollen coat and dress cloths produced in the north of Ireland, either by power or hand weaving, are exported to many foreign markets, though the bulk of this trade is small compared to that of the Irish linen export trade.

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* See *The Silk Industry*, by Sir Frank Warner, K.B.E

SECTION FIVE

COTTON

Early organization of the textile industry in Lancashire—first cotton cloth woven in Lancashire—fustian merchants and the ulnagers—flexibility of Lancashire organization and growth of cotton manufacture—growing dependence of weaver on manufacturer—fustian masters—cotton industry elsewhere in Great Britain—variety of cotton materials increases in Lancashire—East India painted and printed calicoes—calico-printing begins in this country—printed chintz

LIKE ALL OTHER specialized British textile industries, the cotton industry of Lancashire had its origins in the exports of wool abroad, and in the gradual increase of woollen cloth making. In these early stages it went through the same progression of manufacture and internal organization, as the other early wool and worsted manufactures already examined; but development in this part of the country was considerably slower than elsewhere. It is not until the end of the fifteenth century that we find the woollen cloth-making industry of Lancashire organized for foreign trade. This new trade necessitated a different approach to manufacture, for as the local industry had hitherto only produced for its own needs, home-grown flax and wool had been enough to meet all demands. From about 1500 these supplies were insufficient and Lancashire began to import both wool and linen yarn from Ireland and the Midlands—Ireland being the chief source of supply. The industry was still in a less advanced state than in other parts of the country, and the materials produced by it were coarse and of inferior quality. By the beginning of Elizabeth's reign, however, its plain linings and friezes, as well as the light-weight, cheap, and brightly coloured woollen cloths known as Lancashire "cottons" were finding a good sale abroad, in Spain, Portugal, and France; these materials are in no way to be confused with real cotton cloths; they owed their name to one of the finishing processes of their manufacture which was called "cottoning." Lancashire linens were made wholly for home consumption.

During these formative years the same struggle took place between city and country, which occurred elsewhere, but with this difference, that owing to the tardy development of the industry, the corporate towns never exercised the same degree of control over it, as elsewhere, and the victory of the countryside and non-corporate towns came about much more easily and naturally. Lancashire's dependence upon imported supplies of raw material had a very considerable influence on its organization—true, home-grown wool and flax were still in use, some supplied by the great landholders of the eastern border and some by the yeoman smallholders, but the bulk of the material used was imported. The industry continued, as it had from the earliest days, in the hands of the small landholding yeoman class, and as these were largely dependent on imported raw materials, and of insufficient means to finance the purchase of these, a class of middlemen and an elaborate system of credit evolved naturally. The domestic system, by now firmly established in other parts of the country, did not as yet operate in Lancashire. The use of middlemen was only reached after a long controversy, for such dealers were not allowed by law. In 1557 the Lancashire clothmakers tried to get the system of raw material factoring legalized, saying they were: "cotegers whose habylitie wyll not stretche neyther to buye any substance of wolles to maytayne worke and labor, nor yet to fetche the same, the growyth of wolls beyng foure or fyve skore myles att the least."* This plea goes on to say that they could not afford to buy in bulk, and in any case, needed only small quantities at a time with which to make their friezes and "cottons"; if the middlemen were not allowed to exist, the work would fall entirely into the

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* Quoted in *The Cotton Trade and Industrial Lancashire,* by Alfred P. Wadsworth and Julia de Lacy Mann.

(1)

(2) (3 below)

It was a cheap, ordinary cloth and certainly, neither the weaver who made it nor the man who ultimately wore it, could have forseen that it was to be the ancestor of a great new textile industry and that the name of the new-fangled fibre, which the weaver had used as a cheap substitute for wool, would one day be almost synonymous with that of Lancashire. The fibre was cotton, and the cloth was called fustian and was made of a mixture of linen and cotton. (For a very long time all cotton cloths were made with a linen warp as technical means were insufficient to produce a strong cotton warp.) Cotton in itself was nothing new in England, where it had been used for a long time to make candlewicks, for the stuffing needed for quilting, and even as a woven fabric imported from the Continent. (A cotton manufacture had existed in Italy and Spain since the twelfth century, developing later in Southern Germany, France, and Switzerland.) These imported cotton materials were used in all sorts of ways, for making pillows, socks, blankets, and wearing apparel, the two most commonly in use being Ulm fustian and Genoa fustian which were colloquially known as "Holmes" fustian and "Jean" or "Jeans" fustian. (It is interesting to note that the American farm labourer still calls the heavy blue cotton material from which his overalls are made, and sometimes the garment itself "jeans".)

Though the evidence supporting the belief is slight, it is commonly assumed that cotton fustian was one of the "new draperies" introduced by the Dutch and Walloon settlers to Norwich and the surrounding districts of East Anglia. Certainly "fustian of Naples" was made by them on their arrival in this country but this material was partly made with worsted. It has also been suggested that the new material called bombazine, over the invention of which, as we have seen, the Dutch and Walloons quarrelled, might possibly have contained cotton, as bombast or bombazine were words ordinarily used to describe cotton. Whether this is so or not, cotton was certainly used by the Flemings in 1605, being mixed with silk to make a new material called by them "satten cotton bombazie", and the 1611 list of new cloths (already quoted in Section Two) includes a mention of "Fustyn of linen and cotton." Whether the Flemings or the adventurous Lancashire weavers were first in the field is of no very great importance; what is important is that the use of this fibre was to be revolutionary in its effects and it turned Lancashire from a rather second-rate textile area to one of the greatest and most important in England. For the first years after its appearance there are various references to the new fustian, often in the records of litigations; thus in 1609, nine fustian weavers found themselves in Court on the plea of a Blackburn chapman who had supplied them with "fustian wool or cotton wool" for which he had not been paid. Again in 1621, some London fustian merchants, engaged in a wrangle with the ulnagers of the "new draperies," petitioned Parliament saying: "about twenty yeeres past diverse people in this Kingdome, but cheifly in the Countie of Lancaster, have found out the trade of making other Fustians, made of a kind of Bombast or Downe, being a fruit of the earth growing upon little shrubs or bushes, brought into this Kingdome by the Turkie Merchants, from Smyrna, Cyprus, Acra, and Sydon, but commonly called Cotton Woll; also of Lynnen yarne most part brought out of Scotland, and othersome made in England, and no part of the same Fustians of any Woll at all . . . There is at least forty thousand pieces of Fustian of this kind yeerely made in England; . . . and thousands of poore people set on working of these Fustians . . ."*

By 1620, the manufacture of fustian was solidly established in Manchester, and in the export trade was beginning to replace not only Lancashire's own original cheap woollen materials, but also those made in Wales and Westmorland. Fashions were changing, and even the common people were showing some of the love for novelties and gewgaws which was so characteristic of the modes of the Court. (Already in 1577 the Suffolk Clothiers were lamenting the "many slight and vain commodities wherein the common people delight"). The whole textile industry was in a state of transition, not only in England but abroad. The cotton industry in South Germany was dwindling, for it relied on Venice as its main cotton port, with Antwerp as its trade outlet for manufactured goods. With the fall of Antwerp the picture changed and the cotton market shifted first to Marseilles and from there to Amsterdam, Hamburg, and finally to London.

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* Quoted in *The Cotton Trade and Industrial Lancashire*, by Alfred P. Wadsworth and Julia de Lacy Mann.

Brazilian cotton had been shipped for the first time to Europe and our own adventurous New World colonists were considering the possibilities of cotton planting there. Lancashire had chosen the right moment to begin weaving the new fibre.

It may seem strange that a textile industry entirely dependent on an imported raw material should, not only have originated, but been successfully continued, in a district such as Lancashire, which was not only of secondary rank but also comparatively poor and less highly organized than others in the country. But there were several factors which made this growth natural and less surprising than at first appears. Lancashire was the English district where the greatest amount of linen was woven and linen was a necessary part of the new material; the very fact that the industry was less highly organized than elsewhere was a decided advantage when dealing with a new manufacture, for there was a much greater freedom from restrictions than would otherwise have been the case. Manchester, for instance, which was to become the capital of the new industry, was only a market town governed by constables and therefore free from the restrictive regulations in favour of freemen which characterized the corporate towns. The internal organization of the industry had not become fixed into any set pattern and was therefore flexible enough to alter as new conditions should demand; the old selling organization for the wool and linen trades amply sufficed for the first needs of the new trade and grew and developed with it. So it is not really surprising to find that once cotton had been introduced into the district it took a firm hold and continued with considerable rapidity towards the ultimate goal which it achieved. By 1641 it was firmly established, and though in 1650 Manchester's chief trades were described in a contemporary description of the town as consisting of "woolen frizes, mingled stuffs, caps, inkles, tapes, points, etc.," by the beginning of the eighteenth century, cotton goods were taking pride of place. Daniel Defoe in 1727 says that "the grand manufacture which has so much raised this town (Manchester) is that of cotton in all its varieties." But even at this date woollen production was still important, and in 1750 the fatness of the eels in the Irk was locally ascribed to their diet of grease and oils discharged into the river by the woollen cloths which were milled in it.

By the end of the eighteenth century, cotton had taken its place as Lancashire's chief manufacture. An indication of the flexibility of the early manufacturing and business organizations of the industry is given by the fact that this included merchants who followed a modification of the domestic system, buying cloth in the "grey" and having it finished before selling; other merchants who were also themselves manufacturers; weavers who worked for themselves, selling direct to dealers or at the local markets; and weavers who worked for hire. The industry was new, Lancashire had never been completely organized into the existing pattern of its time and old and new systems existed concurrently as the needs of the trade or of the various districts dictated.

By 1700, cotton was used in three different classes of Lancashire manufacture—fustians, heavy bed-tickings and bolsterings and the small-ware trade of tapes and garterings. All the cotton materials made at this time still had a linen warp, though a little twisted cotton was sometimes combined with this. All these different types were made in separate districts and this specialization continued until the mechanization of the industry. There were two different kinds of fustian—with a plain surface or with a cut and raised surface—but there were sub-divisions within these two main categories, according to the use to which the cloth was to be put. The heavier kind was used for making feather pillows, and for strong linings for waistcoats and breeches. A finer kind, which was called dimity, had many uses, from footing stockings to better grade linings; it was sometimes also made with a flowered pattern on the treadle loom, and this kind was used for waistcoats and women's petticoats: there was also a range of striped dimities used for the same purposes as the flowered type.

From the beginning of the eighteenth century the industrial system in Lancashire began to crystallize, the first signs of this being the increasing dependence of the weaver on the merchant, brought about by the invention of the warping mill, which made warping a specialized affair. The weaver who worked for himself could not afford to own a warping mill, and in any case would seldom have had room for one in his working quarters. Warps were made to order for as yet, there were few people with sufficient capital to keep a stock of warps ready for delivery;

for the weaver to order his own warps was impractical, as it might mean a considerable delay in work if, for any reason, the delivery of the warp should be late. So the custom naturally arose that the merchant, as the one member of the industry who could afford such a capital outlay, either prepared the warps himself and gave them out to the weavers as needed, or had them prepared for him and stocked them against future needs. Obviously he was the right person to order the warps as he knew in advance what sort of cloth he would need. From this initial dependence of the weavers on the merchants, there gradually arose a system of control by men called fustian masters or piece masters, who lived among the weavers whom they employed and sold direct to the merchants. Later these piece masters, as well as giving out the warps, began to furnish the weavers with weft in cops, but the practice was soon discontinued as too easily leading to dishonesty of manufacture on the part of the weaver, who could easily attribute faults in weaving to defects in the yarn supplied to him. To avoid this it was found more satisfactory to let the weaver supply the yarns himself, thus assuming responsibility for their quality. As machine spinning came into use and introduced greater uniformity of yarns, the custom of giving out yarns to the weaver came into practice again as providing a better control of the quality of the goods made.

The making of cotton materials had been begun in other parts of England besides Lancashire—at Sudbury and Harehill in Suffolk, at Leominster, Weymouth, Abbotsbury, and a few other places. But these local industries never had the vitality of the Lancashire industry and by the middle of the eighteenth century they were either non-existent or fast disappearing. In only one other part of Great Britain did cotton take a firm hold and that was in Scotland, where, particularly in Glasgow, it developed into a prosperous and flourishing trade. Here cotton and worsted mixtures were made as well as cotton checks and handkerchiefs, the latter becoming an important part of the Scottish export trade, the value of the checks and handkerchiefs sold abroad in 1771 amounting to £46,886. It is worth noting that Scotland, like Lancashire, was a linen-making country and therefore took naturally to the manufacture of cotton.

Meanwhile in Lancashire the variety of cotton materials was increasing; cotton "furniture checks" to replace wool for the lesser sort of window and bed curtains, striped cotton materials for maidservants' gowns, cotton cloth for printing, were all in production by the middle of the century. At about the same time, the first cotton velvet was made which was followed in 1763 by a material called "velveret" and lastly by a material which was to be of the first importance—velveteen. A patent for the manufacture of this was taken out in 1776. At the same time as these new cloths were making their appearance, there was a very considerable improvement in the finishing operations of bleaching and pressing (used to vary the surface appearance of different cloths). Both these processes were in a good state of development by the middle of the century, but dyeing was in a more backward condition, which is somewhat strange as the English dyeing of wool was very good at this time. But the dyeing of cotton presented many technical difficulties due to the finishing operations used, and research into the production of bright, fast colours continued throughout the whole century.

We must now go backwards for a little, in order to trace the beginnings of a fashionable textile vogue which developed into a major branch of British furnishing textiles and which to-day is still unrivalled. In 1631 the East India Company opened trading posts in Madras and other parts of India, for the export to this country of painted and printed Indian cottons, which were known as chintz or calico; these were in very great demand as bed or wall hangings and this fashion continued for well over a hundred years. These materials were covered with graceful and charming patterns in the most delightful colourings which were produced by a limited range of dyes—black, red, indigo, and yellow—but infinitely varied by the use of printed or painted mordants in different degrees of strength; resist wax was also used for certain effects. Every woman of fashion hung her rooms with chintz and the supply was in no way equalled by the demand. Pepys, in an entry in his diary on September 5th, 1663, notes: "Creed, my wife and I to Cornhill, and after many tryalls bought my wife a chintz, that is, a painted Indian calico, for to line her new study, which is very pretty." And an entry in Evelyn's diary on December 30th, 1665, also mentions these materials: "To

Woodcott, where I supp'd at my Lady Mordaunt's at Ashted, where was a roome hung with *Pintado* full of figures greate and small, prettily representing sundry trades and occupations of the Indians, with their habits."

So great was the popularity of these materials that calico-printing in imitation of the Indian models was begun as early as the middle of the seventeenth century, and continued until the beginning of the eighteenth. Neither the quality of the printing, nor of the dyes, of these imitations in any way approached that of the originals, and they were probably intended for a less exacting market which yet wished to be in the fashion. These early home-printed calicoes did not alarm the rest of the textile industry, which does not seem to have paid them any attention. It was quite otherwise in the case of the imported chintzes, which alarmed it to the utmost vocal degree. The climax in the outcry was reached when the Eastern imports began to include, not only the printed or painted calicoes, but certain checked and striped materials and an increasing amount of silk. In 1700, in response to the home manufacturers' complaints, an Act was passed which prohibited the import of the printed or painted calicoes but which allowed the entry of plain cloths on the payment of duty: and an added tax per square yard was imposed on the home-printed materials. The prohibition of the imported calico had the effect of increasing the demand for the home-printed ones, and in 1714 the tax on these was raised by another sixpence a square yard. But the demand again increased; instead of realizing the importance of this new branch of trade, the Government in 1720 took the step of altogether forbidding its manufacture, in an Act ". . . to preserve and encourage the woollen and silken manufacturers of this Kingdom and for the more effective employment of the poor by prohibiting the use and wear of all printed, painted or dyed calicoes in apparel, household stuff or furniture or otherwise after the twenty-fifth day of December, 1722."*

But the woollen and silk manufacturers had not really won the game; the liking and demand for chintz continued and the Act was amended in 1736 to allow the printing of cotton fabrics, provided they had a linen warp; this Act continued to be amended from time to time, and the duties on the printed fabrics were decreased, until it was finally repealed in 1831. Calico-printing therefore continued and a great branch of furnishing textiles, which was later to include many materials besides the original calico, was saved for Britain. The quality of English printing steadily improved from the beginning of the eighteenth century and by 1750, magnificent work of this kind was being produced. The designs were no longer confined to imitations of the original Indian prints but were growing in scope and type. Especially to be noted is the emergence of a type of design which is pre-eminently British and has, since its introduction, continued to be immensely popular both at home and abroad—variations on floral themes. This love of, and skill in, the use of floral motifs is one of the strongest characteristics of British materials, both for dress and furnishing, and though the style of these patterns has varied according to the fashion of the day, an enchanting naturalness and freshness, both of drawing and colouring, has always been one of the most marked features of the best British materials of this kind. From 1750 the delicate sprigged floral designs which had come into popularity were also often combined with a type of printing called "Picotage," in which pins were fastened into the wooden printing blocks to make a background or group of interspersed pin-point dots. The mechanical inventions of the latter part of the century also profoundly affected and enlarged the scope of printing on chintz; throughout the whole of the nineteenth century chintz remained, as it is to-day, one of the outstandingly excellent products of the British textile industry. Though it had its roots in the East, it is to-day as completely and inimitably English as a primrose.

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* Geo. I. 1720. Stat. I.C. 7.

SECTION SIX

THE MACHINE AGE BEGINS

Dutch small-ware loom—John and Thomas Lombe—the Derby silk-throwing mill—Louis Paul and John Wyatt—John Kay's fly-shuttle loom—John Hargreaves and the spinning jenny—Richard Arkwright's water frame—Samuel Crompton and the spinning mule—Edmund Cartwright and the power loom—changes in the industry induced by the machine age—Bell's cylinder printing machine

THOUGH THE WORDS "The Industrial Revolution" automatically evoke in many minds a busy nineteenth-century scene—the unaccustomed air dark with smoke from the countless chimneys of the new industrial age—as far as the textile industry is concerned such a picture would describe the latter phases of the revolution and not its beginning, which dates from the third decade of the eighteenth century. Even before the introduction of the numerous inventions and machines which from 1738 onwards altered the entire aspect of the industry, some simple forms of machinery were in use, the first of these being the first fulling mill, with its water-driven wheel, which replaced the primitive method of fulling cloth by treading with the feet. The English mind always seems to have been receptive to mechanical ideas; in 1757 a contemporary writer proudly boasts: "Few Countries are equal, perhaps none excel, the English in the number of their Machines to abridge Labour," though it is perhaps only fair also to quote the opinion of a Swiss calico printer of 1766: "Everyone knows this nation whose industry and stubborn pride in overcoming every kind of obstacle are beyond all imagination. They cannot boast of many inventions, but only of having perfected the inventions of others; whence comes the proverb that for a thing to be perfect it must be invented in France and worked out in England."* Both opinions were based on fact, but it would be difficult to deny the originality of the numerous British textile inventions of the eighteenth century, upon which standard manufacturing processes are still based. But the two earliest textile machines of importance which were used in this country were of foreign origin: the Dutch small-ware loom (or as it was generally called the engine loom), invented in 1604, and the complicated Italian water-driven machinery for silk throwing which Thomas Lombe of Derby introduced into this country in 1718.

The Dutch small-ware loom accomplished two things—it increased the speed and volume by which ribbons, tapes and similar wares could be woven, and it ended at least one sort of abominable child labour, not because its inventor had any notion of humanitarian principles, but simply because the new loom could only be operated by an adult. The narrow loom which it replaced could be, and often was, operated by children of only six or seven years of age, who were in this way given their first painful lessons in the craft which they were to follow when they grew up. The new loom had twelve parallel shuttles which were moved across backwards and forwards by cogwheels, and though it worked much more slowly than the old type, it could produce more and better woven goods per hour, and also at a cheaper cost, than was possible with the narrow loom, even when employing child labour. A few years after its first use in Holland it was brought to London by foreign refugees, and was very ill-received by the city small-ware weavers who complained of the use of "engines for workinge of tape, lace, ribbin, and such, wherein one man doth more amongst them than seven Englishe men can doe." In 1621 they made an appeal for the suppression of the "develishe invention" and by 1638 the use of "an invention for weaving ribbins and laces in great looms whereby much deceit is practised" and "all engines that shall make at the same time more than one sort of laces or ribbins" were prohibited by the City authorities. (The word "laces" in this connection means the narrow tapes or ribbons for lacing bodices and stays.) The prohibition failed to stop the foreign workers from using the loom, and in 1675 this led to three days rioting and uproar in the City, weavers' houses being forcibly entered and the offending looms dragged out into the street, there to be broken up and burnt. The prohibition had not been supported by the Government and the new looms continued in use. In Manchester, where, since the introduction of cotton, the small-ware trade was assuming a considerable volume, the Dutch loom met with no opposition at all and was soon in general use. The date of its introduction is not exactly known, but it was in operation between 1660 and 1670; it is sometimes thought that it may have been brought to the city by one of the foreign London weavers, attracted by the comparative freedom of a non-corporate town.

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* Quoted in *The Cotton Trade and Industrial Lancashire*, by A. P. Wadsworth and Julia de Lacy Mann.

Derby, the site of the first water-driven silk-throwing mill in England, had had a long connection with silk, the local industry being silk stocking knitting, not weaving; it was also a market for the silk thread used in stocking making, the raw material being mostly imported from Italy. A small silk-throwing mill, later known as the Old Shop, was started in Derby in 1702 but was a bad financial failure. In this unsuccessful mill there worked an apprentice named John Lombe, who was the son of a worsted weaver in Norwich. When the mill closed down Lombe borrowed enough money from his half-brother Thomas to take him to Italy, his purpose being to study silk-throwing methods in that country. He returned to England in 1716 with valuable information and two Italian workmen to act as his assistants. Many legends have arisen as to the means which Lombe employed to get his information, some stating that it was by wholesale bribery, other accounts referring to the connivance of the Italian priesthood. If he used these round-about methods, which is extremely doubtful, they were quite unnecessary, as a complete account of the Italian machinery for silk throwing had been published in Padua in 1607, with later editions published in 1620 and 1686, and as these were very well known it is unlikely that Lombe overlooked them; but to acquire practical experience of the new methods he worked for some time in an Italian mill.

Thomas Lombe, who had lent the money for John's expedition, was a London mercer, and he now fixed on Derby as the location for a new type of silk-throwing mill to be operated with machinery based on the Italian models, for which he secured a patent; the causes for this decision being the town's constant water supply and good reserves of potential labour. The swiftness of the Derwent in Derby was exactly suited to his purpose and he proceeded to rent from the Corporation an island swamp in the river and on this built his mill, which was remarkable, not only for the introduction of new machinery and its success, but also because it was what has been called the first factory, in the modern sense of the word, to be set up in England. It took three or four years to build and is said to have cost £30,000; in its eight rooms there were 468 windows. The venture was successful from the very first, for the Lombes were able to produce thrown organzine of as good a quality as the Italians, at a price with which the latter could not compete. Thomas Lombe was knighted in recognition of his public services and died a rich man leaving an estate of £120,000. There exists a contemporary account of the working of the mill which, though the figures given are said to be somewhat exaggerated, is worth quoting for the description it gives of the intricate machinery: "One hand will twist as much Silk as before could be done by fifty, and that in a truer and better Manner: this Engine contains 26,586 wheels and 97,746 Movements, which work 73,726 Yards of Silk Thread every time the Water Wheel goes round, which is three times in one minute, and 318,504,960 yards in one Day and Night. One Water Wheel gives motion to all the rest of the Wheels and Movements, of which any one may be stopped separately. One Fire-Engine likewise conveys warm air to every individual part of the Machine, and the whole Work is governed by one Regulator. The House which contains this engine is a vast bulk of five or six stories high."*

The mechanical methods which were launched on the textile world during the eighteenth century began with an attempt to improve the first fundamental process—that of spinning. The concentration of thought and invention which was brought to bear on this was occasioned, at first, not so much by a desire to produce yarn more quickly (though this happened automatically with machines), as to obviate other difficulties inherent in the hand process and in the organization of its labour. There was no dearth of trained hand labour for spinning and this method, if continuous, could supply all the yarn that the industry was then capable of absorbing. The trouble lay in the word just used—continuous; spinning was very largely a cottage craft and was therefore liable to seasonal interruptions due to the ordinary work of an agricultural district, so that there was always a bad shortage of yarn during the harvest season, and lesser shortages were apt to occur at other seasons as well. Another difficulty lay in the quality of the yarn spun by hand which, unless made by a very skilful operator, was inclined to vary considerably in fineness and evenness; also as the method was slow it was necessary for the clothier to lock up capital in supplies of various sizes and twists, so as to be able to meet any cloth requirements which might arise, the slowness of hand spinning making it impractical to order specially as needed. In the case of the richer clothiers this question of capital was not so serious, but to the poorer members of this class it presented a real difficulty, so that, as Lewis Paul set out in 1737 in his application for a patent for spinning wool: "Whenever a Clothier has Occasion for a Parcel of Yarn to be spun for any particular Degree of Size or Twist he is obliged to have a much greater Quantity spun than he then wants . . . the poorer Part of the Clothiers are frequently rendered incapable of serving their Customers from an Inability to keep a large Stock of the various Sizes and Sorts by them, and often where Goods are required to be made in great Haste they are oblidged to use such Sorts of Yarn as they have by them or can get, tho' of different Sizes and Degrees of Twist, which often occasions the said Goods to be unsuitly (*sic*) . . ."* Lewis Paul had an associate in this invention called John Wyatt and though the patent was taken out in Paul's name, there has for a long time been a controversy as to whether Paul or Wyatt was the originator of the fundamental idea of the patent—that of spinning by rollers. Wyatt never claimed to be the inventor of the idea and it is generally accepted to-day that this was Paul's, though the working out of the many technical adjustments, which enabled it to be put into operation, were certainly Wyatt's. Briefly, the system of roller spinning consists in replacing the grip of the hand by a set of revolving rollers, a second set of these, working at greater speed than the first, taking the place of the stretch of the arm which occurs in hand spinning.

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* Quoted in *The Silk Industry*, by Sir Frank Warner, K.B.E.

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* Quoted in *The Cotton Trade and Industrial Lancashire*, by A. P. Wadsworth and Julia de Lacy Mann.

Mills to operate Paul's invention were set up in Birmingham, Northampton, and Leominster, but there were certain defects inherent in it, which prevented its general adoption. Though it had originally been intended for the spinning of wool, in actual practice nothing but cotton was ever spun on it. Paul took out a patent for a carding machine in 1748, Daniel Bourn (owner of the Leominster mill) having previously taken one out for the same purpose, earlier in the same year. Neither of these carding machines were of the type ultimately used, but can be considered as the forerunners of the machine finally adopted in Lancashire.

In the days of hand spinning and weaving it was estimated that it took ten spinners to keep a single weaver supplied with yarn; a new invention was patented in 1733, which increased the speed of weaving far beyond that of an ordinary hand loom. This was John Kay's fly-shuttle loom or wheel-shuttle loom as it was first called. In this the shuttle was sent backwards and forwards across the shed by means of the wheels with which it was fitted, and which were operated by pulling a cord attached to a wooden spring at the side. Not only did this loom work much faster than the ordinary hand loom, but broad cloth could be woven on it by a single weaver instead of two. (Two were necessary on the old loom as the width of the cloth was greater than the span of a man's arms, so that it was impossible for a single man to throw the shuttle back and forth from hand to hand.) The fly-shuttle loom also provided better conditions for the health of the operatives, who could sit upright at it, instead of stooping over it, a position which had made weavers prone to diseases of the chest.

For several years after patenting his invention Kay was engaged in constant litigation against infringements of it—the introduction of his shuttle was opposed by the weavers of Colchester and on returning to his native north he was involved in further litigation with the West Riding clothiers, who used his invention but refused to pay his licence fee. He retired to Bury, where an angry mob broke into his house and smashed everything they could lay their hands upon; Kay was smuggled out of their way, wrapped in a wool sheet, by two friends. His applications to the Government met with no reply, and he withdrew to the Continent where later he died. John Kay's son, Robert, continued to live in Bury and in 1760 he invented a mechanism, known as the "drop box"; this made possible the use of two or three shuttles containing bobbins of differently coloured wefts without the necessity of their being changed by hand. By using the drop box, Robert Kay was able to weave materials with striped wefts on the fly-shuttle loom.

The need for some means whereby yarn could be more rapidly spun than by hand was becoming acute; exactly what had happened to Paul's invention is obscure but it had not been widely adopted and had gradually disappeared from view. In 1764 John Hargreaves of Blackburn invented a machine which came to be known as the spinning jenny, because it was said to do the work of a female. This was a frame in which was fixed a row of spindles and a row of rovings, the latter being placed between two flat pieces of wood called the "clove." Part of each roving was attached to a spindle and the thread was drawn from the spindle by the movement away from it of the clove along the horizontal bars of the frame: at the same time a large wheel, turned by hand, revolved the spindles and thus twisted the thread. At first there were only eight spindles in the jenny but later it was found possible for a single spinner to manage sixty or seventy at a time and even sometimes as many as one hundred and twenty.

Hargreaves for some time kept the secret of his jenny to himself, only using it to make weft for his own loom. But the neighbourhood came to hear of the new invention, and convinced that it was something which would imperil their livelihood, a mob broke into his house and completely wrecked the machine. Hargreaves then left Blackburn and settled in Nottingham, where he went into partnership with a joiner and with him started a small factory, which he continued to operate with moderate success until 1778, when he died.

A different type of spinning machine was that invented by Richard Arkwright in 1769. This was a revival and improvement of the roller method begun by Paul, but Arkwright was a very different man, inventive, a great business man and organizer, full of unbounded energy and ideas. His first machine for spinning with rollers was built at Nottingham and the power was provided by horses. A little after this, Arkwright built a new mill at Cromford in Derbyshire, which was worked by a water wheel, so that his spinning machine came to be known as the water frame. The thread spun on the water frame was hard and suitable for warps, whereas that spun on Hargreaves' jenny was softer and better for wefts. Arkwright's other important contribution to textile machinery was an invention for carding by revolving cylinders instead of hand cards. The original idea was the same as that embodied in Paul and Bourn's earlier patents, but without the defects which had nullified theirs. Arkwright's carding system was similar to the modern method for this process.

The next improvement in mechanical spinning to take place was the work of Samuel Crompton, the son of a weaver, who was born at Bolton in 1753. As a youth, he learnt to spin on Hargreaves' jenny and at twenty-one had already begun to work on ideas for improving this. He continued to do so for the next five years, by the end of which time his experiments had reached practical shape. He was too poor or too diffident to buy a patent for it, and apparently only asked to be left alone to enjoy and use his invention for himself. But the rumour got about that he had invented something which improved spinning and he was constantly worried by people climbing up to his window to peer in at him as he worked. He is said to have put up a screen to protect himself, but at last the nuisance got so great as to interfere with his work, and he decided to give his invention to the public. Promised a handsome reward by his fellow townspeople if he would only give them the secret, he released it, only to be most shabbily treated, for all he received was £106; many of the manufacturers who used the invention being mean enough to refuse to pay the paltry guinea subscription, which they had promised. Thirty years later a memorial in his favour was signed by the leading textile manufacturers and this received the support of the then Chancellor of the Exchequer. On the very day that a public announcement was made to friends of Crompton that Perceval, the Chancellor, proposed making him a grant of £20,000, he was shot dead by a madman, and Crompton ultimately only got £5,000, in spite of the fact that his mule was giving employment to 70,000 spinners directly, and indirectly to 150,000 weavers, and that the number of mule spindles in use in the country was nearly 5,000,000. Crompton died in 1827, but well before the date of his death, his spinning mule had replaced both Hargreaves' jenny and Arkwright's water frame. His machine was given its odd name because it embodied principles from both the former machines, rollers on the one hand to draw out and lengthen the rovings, and spindles to give the twist. Its chief feature was that the spindles were not stationary, but were mounted on a moveable box, which ran on wheels. In 1790, the mule was run by water power. We have seen that the water frame spun thread only suitable for warps; Crompton's mule could spin yarn for either warps or wefts, and could produce finer yarn than either of the earlier methods.

We now come to the last and perhaps the greatest of the textile machinery inventions of this period—the power loom. This was the invention of Edmund Cartwright, who was born in Nottinghamshire in 1743. At fourteen he was a student at Oxford, and on leaving the University, he took holy orders and became a curate at Brampton, later being given a living in Leicestershire. He has left an account of how, as a quiet, country parson, he came to invent this most revolutionary of the new textile machines:

"Happening to be at Matlock, in the summer of 1784 I fell in company with some gentlemen of Manchester, when the conversation turned on Arkwright's spinning machine. One of the company observed that as soon as Arkwright's patent expired so many mills would be erected and so much cotton spun that hands could never be found to weave it. To this observation I replied that Arkwright must then set his wits to work to invent a weaving machine. This brought the conversation on the subject in which the Manchester gentlemen unanimously agreed that the thing was impracticable; and in defence of their opinion they adduced arguments which I certainly was incompetent to answer or even comprehend, being totally ignorant of the subject, having at that time never seen a person weave. I controverted, however, the impracticability of the thing by remarking that there had lately been exhibited in London an automatic figure which played at chess. 'Now will you assert, gentlemen,' said I, 'that it is more difficult to construct a machine that shall weave than one which shall make all the variety of moves which are required in that complicated game.'

"Some little time afterwards a particular circumstance recalling this conversation to my mind, it struck me that, as in plain weaving, according to the conception I then had of the business, there could only be three movements which were to follow each other in succession, there would be little difficulty in producing and repeating them. Full of these ideas I immediately employed a carpenter and smith to carry them into effect. As soon as the machine was finished, I got a weaver to put in a warp, which was of such materials as sail cloth is usually made of. To my great delight a piece of cloth, such as it was, was the produce. As I had never before turned my thoughts to anything mechanical either in theory or in practice, nor had ever seen a loom at work, or knew anything of its construction, you will readily suppose that my first loom was a most rude piece of machinery. The warp was placed perpendicularly, the reed fell with the weight of at least half a hundredweight, and the springs which threw the shuttle were strong enough to have thrown a Congreve rocket. In short it required the strength of two powerful men to work the machine at a slow rate, and only for a short time. Considering in my simplicity that I had accomplished all that was required I then secured what I thought a most valuable property, by a patent dated April 4th, 1785. This being done I then condescended to see how other people wove, and you will guess my astonishment when I compared their easy modes of operations with mine. Availing myself, however, of what I then saw, I made a loom in its general principles nearly as they are now made. But it was not till the year 1787 that I completed my invention."*

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* Quoted from *The History of the English Woollen and Worsted Industries*, by E. Lipson, M.A.

Cartwright had the greatest faith in his invention and in 1785 becoming the owner of a property at Doncaster he here set up a spinning and weaving factory, in which he continued experimental work. A bull supplied the power for his machine at first, but water power, and later steam power finally replaced bull power. In 1791 a cotton firm built a factory in Manchester which was large enough to hold five hundred looms and where a few power looms were installed. These were a great success, and produced cloth for half the amount of wages which had been paid for the same amount when hand woven. The weavers, alarmed and angry, threatened to burn down the mill and soon, going beyond threats, did burn it to the ground. Cartwright was ruined, for no other manufacturer for many years—and he had sunk a fortune in his invention—dared install such dangerous machinery. Such was the early history of the invention which has done so much to make possible the wonderful and economically produced materials of to-day.

Once launched on an inventor's career Cartwright continued in it, inventing all sorts of things, from a machine for making bread—which he used in his own house—to a three furrow plough. He was to make one more contribution to textile machinery—a combing machine for wool—which however, was not successful, a good working solution of the problem not being found for another fifty years.

At the end of the eighteenth century the textile industry stood poised on the threshold of the modern world, and the process of re-shaping which was to give it the form we know to-day had already begun. The machines had come into being and despite bitter opposition were to remain, to grow in numbers and efficiency, and completely change the organization of the processes of manufacture. As the break-away from gild control had earlier sent the textile workers away from the towns and scattered them over the countryside, so the age of machinery reversed this process and brought them once more into the cities and towns. This return from the country did not take place immediately, the machines were still worked by hand, or by horse or water power and, as water was both the most powerful and economical form of power, it followed that the new kinds of factories and mills were mostly built in country districts where this was readily available. But with the invention of steam power and its ultimate application to textile machinery, manufacture of all kinds, from spinning and weaving to the finishing processes, was removed from the countryside and concentrated in the towns, thus completely altering the workers' way of life. This alteration in manufacture was accompanied by alterations in internal organization; the days of the clothier and his scattered workers had come to an end for ever, to be replaced by the factory owning manufacturer, with his employees concentrated under one roof.

The tempo of change was not the same all over the country and varied from district to district, according to the type of manufacture—which in some parts was highly localized—so that the introduction of a new machine in one place, might leave another district, which specialized in another type of work, entirely unchanged in its methods and organization. The complete change-over from the old methods to the new underwent three distinct phases. The introduction of large machinery into a worker's cottage was an obviously difficult and dangerous, if not impossible, proceeding. But some of the first new machines were of a size to make it possible for the worker to install them in his usual working quarters, and they were driven by hand power. The spinning jenny was of this type and this could be, and often was, operated under the old working conditions. This was the first phase—improvement in the quality and speed of the work, with little or no difference in the organization. But the continuance of such a system was wasteful and difficult to manage; scattered workers meant that there could be little or no real supervision of their work, and therefore no control of quality. As we have seen, the need for concentration of work to make supervision possible, had quite early in the cotton industry manufacture led to the establishment of groups of weavers working under the control of a fustian master, who lived in their midst.

In the wool industry, the same need of central control had also made itself felt, and in the district around Leeds many of the richer clothiers had already established an early type of factory, with a dozen looms working under one roof, and under the control of a supervisor, generally the clothier himself.

With the coming of the larger machines, and the increasing use of water power to drive them, the factory system arose naturally; the machines were expensive, and needed a large building to house them; the workers were, of necessity, concentrated with the machines, and the second phase of the change occurred. But the first and second phases often overlapped in point of time, both with each other and with the older form of organization; the whole process being gradual and occupying many years. At the end of the eighteenth century, the small factory of the second phase was still comparatively rare. The third and last phase was only reached with the application of steam as the motive power for the machines; here, at last, was an invention which introduced speed into all the processes of clothmaking, and which made possible the three essentials of a modern factory, speed and economy of production, concentration of labour, and complete supervision of all manufacturing processes. With the advent of steam, the older processes were doomed, except in certain instances, where they continued in operation for the production of the very finest and most expensive of luxury materials, such as silk brocade, and damasks for dress and furnishings, and the exceptionally fine woollen dress cloths, such as continued as a crofter's industry in the remoter districts of Scotland. Both these types of manufacture exist to-day, but they are applied to a specialized and luxury trade, that can afford the high prices which such a system, of necessity, involves. And the finest of these silks are to-day made in a factory, though woven on hand looms.

In the woollen industry the change-over was slower and the final phase was not completely reached until towards the middle of the nineteenth century, for the eighteenth century inventions needed much technical improvement before they could produce as fine work as had been made by the old hand methods. The shuttles in the new looms travelled faster from side to side, but at the same time they imposed a greater strain on the yarns because of this speed, so that work had to be undertaken with a view to strengthening the fibre. In 1825 carding, slubbing and spinning were all mill operations and good finishing machinery was coming into being, but weaving was still a hand process. Power weaving, on a large scale cannot be said to have been used much before 1850, and even as late as 1858 there were many hand-loom weavers still working in their own homes, with all the other operations carried out in the factory. But they were the last, and, after the Great Exhibition of 1851, with its large display of the newest textile machinery, the hand-loom weavers' hold on this branch relaxed, and power looms became the accepted method of weaving for woollen materials.

In the worsted industry the complete change-over to power looms took place much sooner for, as worsted yarns were stronger than woollen ones, they took the strain better. In 1836 there were 2,768 power looms for worsted weaving in the West Riding, by 1845 the number had grown to 19,121, and the worsted hand loom was obsolete. In the same way combing machinery did not become completely established before the forties of the nineteenth century, as it needed much adaptation and improvement before really fine combed wool could be produced with it. The change came rapidly when once the machine was perfected; in 1838 all fine wool was still hand combed, but by 1840 hand combing was a thing of the past.

It is sometimes said that in the cotton industry the change-over to machinery was faster than in woollen and worsted, but there does not seem to be any real evidence of this, and much the same course seems to have been followed, hand-loom weaving continuing alongside of power-loom weaving for some length of time. Power looms were not suitable, at first, for all the different kinds of cotton cloth, and only as improvements in these machines took place did their use become general. They were well established by the thirties of the nineteenth century, and after 1845 their use increased rapidly until they completely replaced the hand loom. The slowness in adopting power weaving was again due to imperfections in it, which necessitated considerable technical work before these were overcome. In the early years of its introduction, cloth made by this method was not much more economical than that made on the hand loom, for the warp still had to be dressed by hand. The invention of mechanisms which dressed the warp before placing it in the loom, increased the popularity of the power loom, and another invention which took up the cloth mechanically, instead of by hand, proved to be still another improvement in economy. But the power loom still suffered from defects; for instance, if the weft broke the loom still continued in operation, and when a cop became exhausted the loom had to be stopped, so that a fresh weft could be put in the shuttle. All these disabilities were ultimately overcome, and the use of the power loom advanced rapidly.

The use of the water frame and jenny for cotton spinning was, at first, well-established, but was completely superseded by the mule, which, for a considerable time, was still operated by hand, the first application of power to this being to drive the mule carriage. While the mule was a hand-operated mechanism, it had required one spinner for each machine; by driving the mule carriage by power it was just possible for one spinner to take charge of two at a time. At first, the carriage was only driven forward by power, and had to be sent back by hand; but, as the number of spindles was increased and the carriage made heavier, power was also used to drive it back. This method still called for considerable skill on the spinner's part, the need for which was finally done away with by the invention of the self-actor mule, which made spinning as completely mechanical as power weaving. This invention took place in 1825, and the self-actor mule was further perfected in 1830. But the new machine was extremely expensive, and for many years winding on it was not as good as on the older type of machine. For medium and coarse counts it was in general use between 1850 and 1860; after the cotton famine caused by the American Civil War, and the stimulus for improving machinery for spinning East India and short staple cotton, which this brought about, the use of the self-actor mule became the ordinary practice, though the last hand mules were only scrapped in Glasgow as late as 1887.

Besides the introduction of machinery in the actual making of cloth, there was another mechanical development in relation to the textile industry, which must be briefly dealt with; the printing of material. The chintzes, described in Section Five, were printed by means of carved wooden blocks which were applied to the material by hand. About the middle of the eighteenth century, a method of printing from engraved copper plates was introduced, the method still being a hand one; by the use of these plates finer lines and more delicate effects were possible than by the use of wooden blocks, but the two methods continued simultaneously. In 1771, the first cotton printing works was established at Glasgow, and shortly after this, a method for printing fabrics with wooden cylinders was begun. This method was further improved by a Scot named Bell, who in 1785 invented a machine for printing cloth with polished metal cylinders on which the design was engraved. This machine was the direct ancestor of the cylinder printing machine for cloth of to-day, and embodied all its main features, the rotating cylinders which pass through the dye bath before pressing the design on the cloth, and the metal "doctor" blade for removing excess dye. A contemporary writer, describing this machine, says: "By this process it was found that a machine could produce some 5,000 yards a day, which would be the work of 42 block printers in the same time."*

Bell's original machine was improved in 1790 by an inventor named Nicholson. Many fabric printing works soon began operations, the greater number of these being situated in Lancashire, but there were also important installations of the same kind in Carlisle and Glasgow. Fabric printing to-day is carried out by three methods, the old wooden hand blocks, which are still unrivalled for certain effects, by cylinder printing machines, and by a method of recent introduction:—silk screen printing. A description of these methods will be found in Part II, Section Twelve.

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* Quoted in *English Chintz*, by Frank Lewis.

SECTION SEVEN

RAYON

Dr. Robert Hooke and René de Réaumur—Louis Schwabe demonstrates before the British Association—E. Gottfried Keller, Hugh Burgess and Charles Watt—Georges Audemars uses Schoenbein's method of making nitro-cellulose in his patent for making artificial silk—later patents—Sir Joseph Wilson Swan—Count Hilaire de Chardonnet—Charles F. Cross and Edward Bevan discover "viscose"—Courtaulds Ltd. begin manufacture of artificial silk and build their Coventry factory—first patent for the acetate process taken out—Henry and Camille Dreyfus—British Celanese Ltd.—British Bemberg Ltd.—long cut-staple

IN THE TEXTILE INDUSTRY, the late eighteenth and early nineteenth centuries period was distinguished by the introduction of machines and mechanical power which completely reorganized the system of manufacture. A century later, another great innovation brought many changes of manufacture to the industry; this was the perfection of the synthetic fibre to-day generically known as rayon.

Though rayon is a comparatively recent addition to the family of textile fibres, the *idea* of such a fibre goes back at least three centuries to the ingenious theories of Dr. Robert Hooke who, in his book *Micrographia* (1664), argued that as silk was a glutinous excrement of the silkworm, it could reasonably be inferred that this might possibly be produced artificially by finding a suitable substance and drawing it out in a continuous thread. The idea remained no more than an idea, until towards the end of the eighteenth century when experiments in drawing out filaments from the gum of dead silkworms were conducted in France. Shortly before this the French scientist René de Réaumur had also toyed with the idea that, as silk was only dried liquid gum, it should be possible to make artificial silk by combining gums and resins together.

Nothing more happened until 1841 when a certain Louis Schwabe demonstrated before the annual meeting of the British Association, which was held in Manchester, a machine which he had invented for spinning artificial fibres. Louis Schwabe was a prominent silk manufacturer in Manchester and the filaments which he demonstrated before the British Association were spun from glass. He stated that he was not satisfied with this substance for the purpose and asked the help of the Association in "carrying out experiments which would lead to the discovery of a substance which would form a homogeneous mass possessing the qualities of ductility and susceptible to being drawn out through fine holes, or otherwise into filaments or fibres possessing suitable strength and other properties to adapt it for manufacturing purposes."* Nothing came of his idea as the Association did nothing to help him; it is interesting to note that in this request he outlined the spinneret method which was to become the standard rayon method for producing filaments.

At about the same time that Schwabe was demonstrating his new machine, a Saxon weaver called F. Gottfried Keller, while watching children grind cherry stones, noticed that the powdered wood from the stones was floating on the surface of a nearby pan of water. He squeezed some of this pulp in his hand and observed that it very soon assumed the consistency of old rag pulp. He continued to experiment along these lines, but sold his rights for a trifling sum. Soon after this, patents were taken out in America by two Englishmen, Hugh Burgess and Charles Watt, for the manufacture of wood pulp, and another patent for similar processes was taken out in England by two other men in 1851 and in 1857. Though this innovation seemed at first only relevant to the paper trade, it actually made possible viscose rayon, and therefore had an immense influence on the textiles of the modern world.

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* Report for 1842 of the British Association.

The discovery of gun cotton by the Swiss chemist, Schoenbein, in 1846, was another step towards the making of rayon, though again nothing of the sort was in the mind of its inventor. The first actual patent for the production of artificial silk was taken out in England in 1855 by a Swiss called Georges Audemars, who used Schoenbein's method for making the nitro-cellulose basis of his patent. Next came a patent taken out in 1857 by Edward Joseph Hughes of Manchester, for drawing out filaments from a curious mixture of fat, glue, gelatine, oil, wheat, and cellulose, which however never proved successful. From this time until 1884 a good deal of experimental work continued which was directed towards the production of an artificial filament; but during this time the main objective was, not a search for new textile fibres, but for filaments suitable for electric light bulbs. The most successful of these electric light filaments were those produced from cellulose by Sir Joseph Wilson Swan, and which were later used in the Ediswan electric bulbs. Sir Joseph's method was to squirt nitro-cellulose, emulsified in acetic acid, through a small die into a coagulating bath of alcohol, so that it formed into threads of indefinite length, being afterwards denitrated. He was struck by the textile possibilities which the new filaments seemed to present, and made some in especially fine diameters, with a view to carrying out experiments with these. Some of these threads were crocheted into mats and were exhibited at the Inventions Exhibition of 1885 and called "artificial silk." Sir Joseph patented his nitro-cellulose filaments in May 1883; in May of the following year Count Hilaire de Chardonnet took out a patent for ". . . une matiere textile artificielle ressemblant a la soie." De Chardonnet had been working quite independently and had been engaged on experimental work on artificial filaments for over thirty years; he was the first to produce multi-filament yarn. Later in the same year in which de Chardonnet's patent was taken out, a factory was opened at Besançon to manufacture the new filaments; trouble shortly ensued, for, as the filaments were not denitrated they were highly inflammable. The English textile journals issued warnings on the grave dangers incurred in wearing materials made from such filaments, and presently the French Government forbade their manufacture.

At this stage, de Chardonnet adopted Sir Joseph Swan's denitration process, but his company's shares had already fallen so badly that the capital was reduced from the original six million francs to one and a half million. The denitration of the filaments, however, saved the day, and the Besançon company was soon in active production once more, and by 1895 was a highly prosperous concern. At the International Exhibition in Paris of 1889 there was a large and important exhibit of Chardonnet yarns and woven fabrics.

Meanwhile, two young English chemists, Charles F. Cross and Edward J. Bevan, were working at their laboratory in Kew on experiments in vegetable fibrous matter, and during the course of these they discovered that if cellulose, whether obtained from wood, flax, cotton or other sources, was treated with caustic soda and the resultant product then subjected to treatment with bi-sulphide, a new, highly viscous compound, soluble in water or caustic solution was formed. The solution of this compound, whether in water or caustic soda, was named "viscose." After a series of experiments, filaments were finally made by forcing the solution through jets, and in May 1899 a patent covering the making of artificial silk from viscose was taken out. Many other experiments were necessary before the process was finally perfected and a company formed in 1902 called The Viscose Development Company Ltd.

The Board of Courtaulds Ltd. had become interested in artificial silk after a visit to the Paris Exhibition of 1900, when this again formed an impressive exhibit; and in April 1904 the Board were offered the British rights in the process by the Viscose Spinning Syndicate. At this stage Courtaulds initiated a good deal of investigation, and other methods of making artificial silk such as Chardonnet's and the cuprammonium process of Germany, were considered. The Viscose Spinning Syndicate's offer was at first refused, but two months later the Board reversed their decision, and so the first decisive step was taken towards making the firm's name world famous as producers of one type of rayon. (The name rayon which is now universally adopted, did not come into being until 1926 when the Silk Association of Great Britain and Ireland—now the Rayon and Silk Association—decided that much harm was being done to the new textile filament by the incorporation of the word "artificial" in its description, and that a generic name to cover all the different types was advisable. In 1927 the use of the new name was made effective throughout Europe by Courtaulds announcement that it had been adopted by them for their materials.) In 1904 Courtaulds built a factory in Coventry, in which to produce the new filaments; and after initial difficulties and disappointments, manufacture continued here from 1906 onwards. The first fabric made from the company's new yarn was woven at their Halstead mill in Essex, and from this time the yarn made at Coventry was woven in the firm's Essex silk weaving mills. Progress was fairly slow, but by 1909 success for the new material seemed, as indeed it was, assured. The viscose rayon process is probably the most important of the three standard ones in use to-day, the others being the acetate and the cuprammonium processes.

Of these, the acetate process runs viscose very close in importance and volume, and is a firmly established industry in this country. The first patent for this process was taken out by C. F. Cross in 1894, and it continued the subject of intensive experimental activity for a number of years. The brothers Henry and Camille Dreyfus first brought commercial success to it, and invented the name "Celanese" which to-day is a household word. Henry Dreyfus was a research chemist and it is due to his unremitting work that acetate rayon was finally brought to its present high standard of quality. In 1916 he erected, at the request of the British Government, a factory for the manufacture of cellulose acetate airplane dope, and here during the remainder of the 1914–18 war ten tons of dope a day were manufactured. After the war, Mr. Dreyfus was faced with the necessity of finding employment for the dope-making factories, and for this purpose turned towards the development of cellulose acetate yarn. This presented considerable difficulties at first, due to the bean-shaped cross-section of the filaments, but an ingenious method was found by which to overcome this defect. The next problem which presented itself was that of finding suitable dyes for the new yarns, and when this was solved, it was found that entirely new techniques for weaving and knitting had to be found. In connection with these, the firm of British Celanese Ltd.

ultimately built their own weaving and knitting plants, in which many exciting new developments took place, such as the use of shuttle-less looms and circular looms. To-day, the firm of Celanese have a large and excellent range of soft dress and lingerie materials, as well as a variety of furnishing cloths.

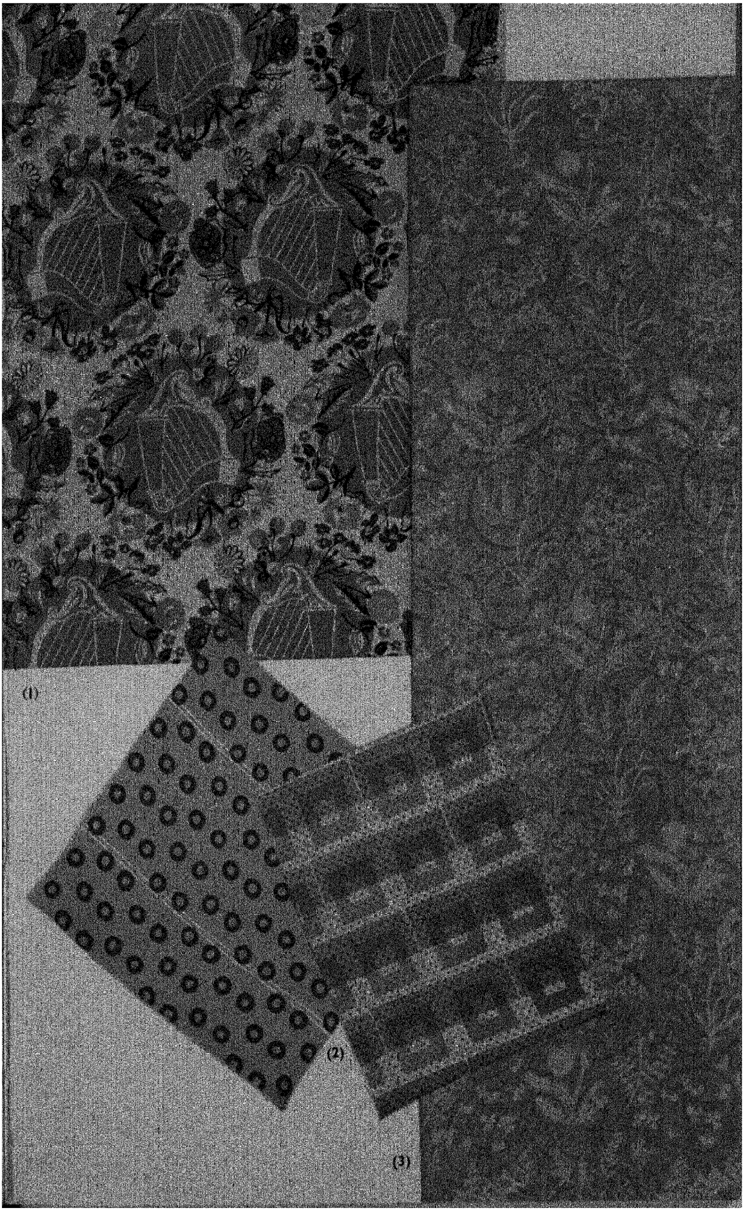
There is only one firm in England which produces rayon by the cuprammonium process—British Bemberg Ltd. This firm has its factory at Doncaster, where production began in 1931. By far the largest use of the Bemberg yarns is in the making of ladies' stockings and locknit underwear, and a certain amount is also used by makers of outer wear and tie silks. There are also a few *crêpes de Chine* and *crêpes* georgette made from this yarn which are soft and have high tensile strength.

During the years immediately following the end of the 1914–18 war rayon came into its own, and became an indispensable and ever-growing part of the world's textile fibres; since the early days when it was somewhat stiff and unfriendly in handle, and suffered from too pronounced a surface sheen, it has developed into a luxury material at a medium price; lustre is now controlled so that it is an asset, its draping qualities and softness of handle are second to none, and it both prints and takes dyes in a brilliant and admirable way.

Just before the outbreak of the second world war, a new development in the use of rayon yarn took place, of which we have, as yet, only seen the early stages but which promises to be as momentous and revolutionary in its effects as was the actual introduction of rayon itself. This is the use of cut-staple fibre, adaptable to the textile machinery of the wool, cotton, and linen branches of the industry. The importance of this can be gauged by considering the chief characteristics of the three great natural fibres, wool, flax, and cotton. Wool fibres have length but not fineness; flax, length but not overall fineness; and cotton, fineness but not length. Rayon cut-staple can be controlled so that length and fineness can be combined in almost any desired way, and to these, great strength and extreme elasticity are likely to be added in the near future. By means of this control of length, rayon cut-staple can be made to fit any existing textile machinery, and this versatility makes it possible

PLATE III

(1) Heavy furnishing linen, screen-printed with a design by Marion Dorn, showing an Irish harp and wild flowers. *The Old Bleach Linen Co. Ltd.* (2) Two lightweight furnishing materials printed with combinations of the basic prints described in Plate 47. *Edinburgh Weavers.* (3) Heavy Jacquard-woven rayon and cotton furnishing material, screen-printed with a design which repeats the motif of the weave. *James Sterling Ltd.*


(1)
(2)
(3)

to produce new materials with many characteristics of the yarn for which the machinery was originally made, as well as the special traits of rayon. It can be used alone or in unions with other materials, and the range of combinations and permutations obtainable with it is almost endless. To-day, rayon cut-staple specially made for cotton machinery is producing materials in Lancashire that are quite unique; in Belfast, rayon staple cut to the longer lengths needful for linen machinery is creating a whole new industry alongside the city's great speciality of woven linens, and on the wool and worsted machines it is being used to make a range of soft, light, wool-like materials of special fineness and appeal. The use of rayon cut-staple has only just begun, but already the materials made with it have great value and charm, and can in no way be considered as imitations of the fibres on whose machinery they are spun and woven. While acquiring by the manufacturing process some of the attributes of the natural fibre, they remain unmistakably new materials. The world is starved to-day for textile fibres and the advent of these new and exciting cloths, made with long cut-staple either alone or as unions with other yarns, offers the possibility of ample quantities of beautiful clothing and furnishing cloths at most economical prices.

SECTION EIGHT

BRITISH TEXTILES TO-DAY

Concentration of industry in cities—Yorkshire—the West Country—Wales—Scotland—Northern England—Belfast

THE MECHANIZATION OF the British textile industry has resulted in its becoming concentrated into much narrower and better defined areas than in its early days; some towns gradually absorbed all the textile life of a district, and expanded and increased in size until they have become the great clothmaking cities of to-day. Occasionally a once prosperous district has declined, and this is the case in East Anglia which, once one of the greatest of the early English clothmaking centres, has completely fallen from its proud position. This fall is chiefly due to the great opposition to power spinning and weaving in Norwich and its surrounding districts, which was so determined that in 1849 there were only 428 power looms here in contrast to Yorkshire's 30,850. Competition on such unequal terms was impossible, and the worsted industry, for which the town had once been famous, was completely relinquished to the West Riding of Yorkshire.

There is a current saying that "In England they make worsteds and in Scotland wool," and though this is not strictly accurate, for very many fine woollen cloths are made in England, yet the fame of the West Riding's worsteds is so great that it often overshadows the fine quality of the English woollens made in the West Country areas. In the West Riding, Bradford is the great textile town and it is also the centre of an important dyeing industry, for the Bradford Dyers Association is one of the largest organizations of this kind in the world. As a city Bradford owes its growth entirely to textiles and the coming of the machine age. In 1800 it had one spinning mill and 13,000 inhabitants; fifty years later its population was over 100,000 and there were about a hundred and thirty mills with power-driven machinery. And its growth still goes on.

Besides the worsted industry of Yorkshire, this county also has a very important manufacture of heavy woollens such as army cloths, heavy naps, beavers and boltons, Astrakhan cloths, suitings, blankets, and rugs. In the last few years too, both English and Scottish manufacturers of woollens have perfected the printing of these fabrics and many ranges of printed woollens are now produced in weights and designs suitable for both dress and furnishing purposes.

In the West Country although the textile industry has vanished from a few areas, this district is still a great centre of woollen cloth making, and it also produces a certain amount of worsteds. The most important manufactures are situated in Gloucestershire, Wiltshire, and Oxfordshire, and there are also some fine materials made in Somerset. The specialities of the West are the finest of suiting and coat cloths, flannels, cloths for car upholstery which have evolved from the old carriage cloths, printing press and tennis ball cloths, hunting and naval cloths, box cloths, tweeds; it is also the headquarters of the blanket industry.

In Wales, the new machinery converted a tiny local cottage industry into a flourishing factory one, though it was still very small in comparison with the other British branches and almost entirely devoted to the production of a single cloth—Welsh flannel. From 1800 onwards hundreds of small factories were built all over the Welsh valleys, driven by the abundant water power of the locality. The industry was at its peak in the years between 1800 and 1850, and exported its flannels to England and abroad; after 1880 Welsh flannels lost their popularity, chiefly owing to the increasing use of knitted materials in the underwear trade. Though, from this date until quite recently, the textile industry steadily declined in the Principality, it has never completely died out, the Welsh manufacturers stubbornly continuing to produce their traditional cloths by the old methods in their small water-driven factories. They were however, until quite lately, highly conservative, and paid little or no attention to the changes in popular taste brought about by shifting fashions, and though the excellence of the Welsh flannels and tweeds was known and appreciated by a limited public, they had not the world-wide fame of the Scottish rural woollens—the industry remained a small and unimportant local one. To-day, all this is changing, largely owing to the efforts made a few years ago by the University of Wales, which conducted an extensive survey into the conditions prevailing in the industry. The first result of this was the appointment of a technical officer whose chief duty was to help the local manufacturers to improve their cloths and to bring them into line with modern needs. From this initial step grew the Welsh Textiles Association Ltd., of which most of the woollen manufacturers in Wales are now members. The Association exists to guide and advise manufacturers, to publicize the industry and to establish it as an important part of the British textile industry as a whole. In these aims it is meeting with a large measure of success, and the seventy-five small woollen mills which are in production in Wales to-day form the nucleus of a steadily expanding industry.

Welsh manufacturers are not mass-producers, and they include both individual hand-loom weavers and owners of small factories employing a certain number of operatives; the industry is still a specialist, rural one, and, wisely, no attempt is being made to alter this character. Instead, its individualistic tendencies are encouraged, and each mill produces a considerable number of different cloths in small quantities, instead of specializing on the production of a greater volume of a single type of cloth. The materials are all woollen, and the famous flannels with their beautiful, soft handle and excellent wearing qualities, are coming into their own again, especially in the making of men's shirts; at the same time some excellent tweeds are being made both for home and foreign consumption. These two cloths remain the most important items of Welsh textile manufacture, but the making of heavy furnishing materials, as well as scarves, travelling rugs, blankets and knitting yarns is also increasing. The industry is once more alive and, though completely modern in its outlook, is bent upon developing to the full its own special and traditional character.

In Scotland, on the contrary, the impetus given to the industry by the new machinery has never died out, and the industry here has grown steadily ever since its introduction. In Lanarkshire there grew up a thriving cotton industry, to which later were added the making of light silk and woollen shirting cloths; in Paisley, once the home of Scottish silk, were made the famous light wool shawls copied from the Kashmiri ones, which Queen Victoria made fashionable. These were of the most exquisite fineness, with colourings of great purity; for many years no woman with any pretence to fashion, could afford to be without one, and only the caprice of fashion, which suddenly removed shawls from the feminine wardrobe, brought an end to this interesting manufacture. To-day Paisley makes great quantities of sewing threads, and there are important finishing works in the neighbourhood. Glasgow, early the scene of a cotton industry, where indeed, ginghams and zephyrs were both first made and named, to-day still makes cotton cloths but to these have been added light woollens and rayon dress goods. Here, too, originated Madras muslins, which replaced the stiffened board-like, bleached lenos formerly used for inner window curtains. First made on hand looms, they are produced here to-day in great quantity on power looms, both in cotton and rayon. Scarves and rugs are also made in Glasgow and its district. From the west coast come a great variety of woollen dress and coat cloths of all sorts, while in the remote Outer Isles and in the Highlands are still made, and by the same methods, the unsurpassable hand-woven tweeds, which were produced here from the earliest times. Linen making is concentrated in Dundee, Perth, and Dunfermline. In Dundee some fine furnishing materials, both in fancy weaves and printed, are made, and it is also the home of a great jute industry. The furnishing fabrics made in Dundee have a special quality of their own which is quite unlike that of any produced elsewhere in Great Britain. The fibres used are cotton, flax and rayon, and from these, most interesting cloths are made, either alone or in unions; a certain amount of jute is also sometimes used for some of these materials. But all of them are very strongly influenced in their construction by traditional Scottish designs and methods and, though produced by power looms, they have a certain rugged, homespun appearance. They are, in fact, modern interpretations of cottage weaves, with the original simplicity of conception retained, but transmuted into materials suitable to the more sophisticated needs of to-day. The chief interest and attraction of these materials lies in skilful mingling of fibres, and in the highly complex and varied surface textures given to them by inventive developments of native weaving traditions. The colourings used also show an easily traced native influence in the softness and richness of the colour scale used. Attractive printed furnishing materials are also made in this town, and further interest is given to the typical textured cloths by over-printing, either by silk-screen or hand block methods, the patterns used ranging from those based on traditional documents to a large number of completely modern and adventurous designs. In fact, Dundee furnishing materials are notable, not only for the excellence of their quality and workmanship, but also for their variety and first-rate design. And in the border country, with Galashiels as its centre, are made an infinite variety of dress and suiting cloths, from the classic cheviots and saxonies and sober and sturdy tweeds for sports wear, to the whole range of brightly coloured or pastel tinted special tweeds which have been developed for the women's fashion trade both at home and abroad.

In Lancashire, cotton still reigns supreme, though to-day rayon is a powerful rival to it in this district; and especially is this so since the introduction of the new long cut-staple rayon which is so suitable for cotton machinery. The variety of cloths made in Manchester and its surrounding districts is almost past counting; dress and furnishing cloths of every kind made of cotton or rayon or in mixtures of these two yarns—plain weaves and fancy weaves—shadow prints, block prints, cylinder prints, screen prints and reversible prints—shirtings and pyjama cloths and rayon tie materials—sheeting, towelling, bed tickings, overall cloths and winceys and winceyettes. But the weaving of this varied assortment of cloths is only one part of the textile industry in this county—here too are situated the many great mills where the raw cotton is prepared, spun and doubled into the yarns and threads used in the weaving sheds, as well as the equally large and numerous works where the intricate processes of bleaching, dyeing, printing and finishing are carried out. In this county are also made the engraved copper cylinders used in the fabric-printing machines, some in special departments attached to the printing works, but mostly by firms exclusively devoted to this highly specialized and skilled type of work. And, just as at the end of the eighteenth century Great Britain pioneered in the making of copper printing plates, the supremacy of which was everywhere acknowledged, so to-day she produces engraved copper printing cylinders which are unequalled anywhere else in the world for their quality and fineness of craftsmanship, and which are one of the most important factors contributing to the excellence of British printed materials.

Apart from the materials already mentioned as being made in Manchester, there is another type of specialized cloth which forms a separate and very important branch of Lancashire's textile production—trade cloths for export to Africa, India and the South Sea Islands. These cloths, though produced in enormous quantities, are almost unknown to the rest of the country, for they are made exclusively for the native markets for which they are so carefully and brilliantly designed; yet they are some of the most beautiful and exciting materials produced by Great Britain. To visit a warehouse department where these materials are stored is an unforgettable experience which transports one into a fantastic and romantic world of strange, heavy colours and exotic design. And all these materials are the product of the imagination of Manchester designers who are steeped in the traditions and tastes of far away native populations with whom they may never have had actual personal contact. The indictment of insularity, so often levelled at British designers, can never be better refuted then by examining a collection of such Manchester designed and produced goods. Each of the native markets has its own special fashions and colour preferences, which must be meticulously observed. In West Africa the printed designs must conform to certain conventions, but within these they can be changed, and indeed *must* be changed, as often as possible. But the range of colours in which the patterns are printed must always remain within a certain well-defined range, or the native buyer will have none of them. This colour range is chiefly made up of deep indigo blue, dark maroon, heavy dark greens, ochre yellow and all tones of brown and cream. The reason for this colour preference is said to be the colouring found in the West African landscape, against which these deep, sombre tones take on great richness; whatever the reason, the fact remains that no other type of colouring will find a sale in this particular market. The cloths made for this part of Africa are lightweight plain-weave cottons in continuous lengths; the type of colouring used necessitates the very finest kinds of resist and developed dye printing, a kind of printing, in fact, which normally is only used for the best quality silks and rayons. But the intricate designs and deep rich colours which the West African native demands can be produced in no other way.

In East Africa the demand is for something quite different; whereas in West Africa representations of the human form (or parts of it such as eyes and feet!) are much liked, in East Africa with its largely Mohammedan population, these are taboo. Geometric shapes and conventionalized floral motifs must take their place. The colours for this market are also quite different—bright primary reds and yellows, brilliant magenta-pinks and sharp blues being the favourites. And the actual cloth, while still a plain-weave cotton, must be made as separate table cloths, often with intricately patterned borders enclosing a patterned centre. These tablecloths are used indifferently by their purchasers for their original purpose, for clothing, or as bedspreads.

For India, fine cotton cloths are produced in continuous lengths, but printed with patterns which are arranged as to allow of the material being cut into standard "sari" lengths, each of these having a border at each end, and containing within them a complete and unbroken design.

For the South Sea Islands the Manchester trade departments make "pareo" cloths—again lightweight plain-woven cottons in continuous lengths. These are printed with very large and florid single colour designs, almost always deep blue or scarlet on white grounds, or white on blue or scarlet grounds. Some other colours are sometimes used, but they are always of extreme brilliance. An amusing memory is concerned with the return, some years ago, of a globe-trotting friend with a trunk filled to overflowing with such "pareos" intended for beach wear on the Riviera, and his chagrin on being told that he might have procured these at their source by taking a much shorter journey!

A very new Manchester development is the transference of some of the less fantastic of the West African designs onto heavy rayon cloths intended for making up into men's dressing gowns; a use for which they are extremely well adapted. And many of the other specialized trade goods designs are being adapted for cloths suitable for modern beach wear, house coats, and furnishings.

Further to the north, Carlisle is a great centre for two different branches of the industry: the finest of woven and printed furnishing materials and light rayon and cotton dress materials of every kind. There are also great finishing, dyeing, and printing works in this city and this was the district where modern fast to light dyes were first brought to perfection in this country. The story of this achievement is important and though the scene of it is laid in Carlisle, the firm responsible for it was founded by a Scot—the late Sir James Morton, whose father and mother were both hand loom weavers. After serving an apprenticeship in the kinds of weaving controlled by his father—tapestry, leno, chenille and lace—James Morton was, for a number of years, an active partner in a firm of carpet manufacturers. In 1900 he and his partners acquired a factory in Carlisle, where different kinds of tapestry and other furnishing materials were woven. From here, in 1904, the firm launched a series of yarn-dyed materials which carried a fastness to light and washing guarantee, to which, soon afterwards, was added a range of printed casement cloths carrying the same guarantee. The guaranteed fabrics were subsequently given the trade name of "Sundour" and shortly before the 1914–18 war, a new company called Morton Sundour was formed for the Carlisle materials. The outbreak of this war immediately brought grave difficulties, not only to Carlisle, but to the rest of the British textile industry, for it completely cut off the supply of German dyes and chemicals upon which it was, at that time, largely dependant. It was necessary to start from scratch, and in some way to evolve vat dyes without any German chemicals whatever. The difficulties in achieving this seemed, at first, almost insurmountable, but Sundours continued the most extensive research work, and by

1919 the Carlisle works were producing nearly fifty per cent more of a certain vat dye than the country's total pre-war imports of this from Germany. Other dyes followed, and the problem was solved with inestimable advantage to the British textile industry: for whereas at the beginning of the 1914–18 war it had been almost entirely dependant upon Germany for dye stuffs, at the outbreak of the second world war, Great Britain was producing approximately ninety per cent of its own dye requirements.

But, important as are the dye developments of this Carlisle firm, they are equalled by the quality and variety of the magnificent furnishing materials made by it and by its subsidiary company—The Edinburgh Weavers—which was formed for the purpose of producing machine-woven contemporary designs. This purpose has been brilliantly achieved and the services of British designers of the first rank have been retained, and most fully and imaginatively employed. In addition to the many novel woven materials made, both in Carlisle and by the Scottish branch, many beautiful printed fabrics of contemporary design also form part of both factories' production.

Across the Irish Channel stands the great city of Belfast with its amazing linen industry which completely dominates the town and the country for thirty miles around it. For, great as is this industry (indeed first in the world), it is yet completely bounded within this comparatively small area. Every street seems to contain at least one great linen warehouse, and the countryside round about the town is dotted with spinning and weaving factories. A few of these are in Belfast itself or in its suburbs, but a unique feature of this industry is the fact that, though its equipment and factory planning are completely modern, much of it is sited in the open countryside or in sleepy little market towns. So that something of the old country atmosphere of earlier days is still retained by this essentially modern branch of British textiles. Here are made the magnificent double damasks, the finest of household linens, gossamer-like sheer handkerchiefs, beautifully woven furnishing materials, some plain and some printed, dress linens of every type and colour as well as the homelier aspects of linen, such as kitchen cloths and sturdy garden chair coverings, and awning cloths.

To all this variety has been added another kind of material which the shortages of the last war brought into being—long cut-staple rayon, spun and woven on standard linen machinery. Here is a wonderful material, with either the softness and handle of wool, or silk-like in texture, in every kind of weight or quality, and for every possible dress or furnishing use. Forced back upon this new fibre by the shortage of flax in the war years, the Northern Irish industry has developed a magnificent new range of materials which are daily becoming more and more important, and bid fair to become as great a part of this district's production as is linen. Northern Ireland has always been noted for its heavy furnishing linens, but this new use of long cut-staple yarn on linen machinery has added another type of material to these. The furnishing cloths made from this yarn are produced in many different kinds of classic weaves, both plain and Jacquard, but their most interesting development consists of a range of Jacquard weaves which are overprinted, by the silk screen process, with precisely the same design as that used for the figured ground. No attempt is made to register the two designs, and the print is allowed to fall quite loosely on the woven design, with extremely happy results. In some lights the woven design is almost invisible, and the print dominates; in others the weave breaks through upon the print and gives it light and shade. Printed designs on a figured ground are not new in themselves, but up till now the two designs have only born the slightest, if any, relation to each other. This expedient of repeating the same design in both weave and print, simple as it is, opens up all sorts of novel decorative possibilities.

Travelling from country factory to town warehouse, seeing and handling all the variety of desirable materials made here, one is struck by the immense vitality and inventiveness of the industry as a whole; and everywhere between factories and towns lie the fields with their crops of growing flax.

And finally we come to another factor of modern British textiles which is reproducing some of its earlier aspects—the influx into this country once more of first-rate technicians and designers, driven from their countries by conditions on the Continent in the last fifteen years. Already the inventiveness of one of these newcomers has produced in this country a cloth such as had never before been made anywhere else—a wool of such gossamer weight that an entirely new method of weaving had to be evolved to produce it. For a long time now it has been possible to spin woollen or worsted yarns of so fine a texture that it was impossible to weave them without their breaking. Many methods of overcoming this difficulty were tried, for cloths woven of such fine yarns would possess suppleness such as no wool had ever had before; they would give dress designers fine clinging sheers with which to create new fashions, and for underwear they would combine aesthetic appeal with wool's known hygienic value. But the fineness and delicacy of the yarns continued to baffle the weaving technicians. The problem was finally solved by the use of carrier threads to support the yarn during weaving, and to give the necessary additional strength. The use of carrier threads was in itself nothing new, for it is a technique often used for fine yarns. What was new and really revolutionary was the choice of material for the carrier. Heretofore these have always had to be dissolved, after the cloth was woven, by the use of chemicals which tended to spoil the lightweight yarn as they disintegrated the carrier. The new material chosen to support the fine yarn was finally evolved by one of the experts from abroad, working in conjunction with the University of Leeds: it is an Alginate yarn which is made from seaweed, which is soluble in a light alkaline solution. Such a solution is part of the normal scouring process undergone by the cloth after weaving and during this the Alginate completely dissolves, leaving behind it a pure wool cloth of the almost incredible weight of one ounce to the square yard.

The new method of weaving described in the last paragraph is but one among many new ideas which our industry owes to this fresh influx of foreigners to this country. Many are still in the experimental stage, others are already in full production. Of these, two of the most notable are a range of delectable printed Sea Island cottons with an entirely new silk-like finish and surface sheen produced by a well-known Dutch textile expert; and the range of dress materials and scarves sponsored by a young Viennese textile expert, which is entirely designed by famous British artists such as Henry Moore and Graham Sutherland. Once again foreigners have made their new homes in this country, young men and women with keen inventive minds, eager and willing to impart the knowledge of their skill to our own industry—and this time the suspicion and dislike which marked the reception of the earliest Flemings is happily absent. The newcomers are already absorbed into our textile world, which is the better and the fresher for their influence.

Part 2

SECTION NINE

THE TEXTILE FIBRES

Wool—silk—flax—cotton—viscose rayon—acetate rayon—cuprammonium rayon

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FIBRE IS THE NAME given to the raw material from which textile threads and yarn are manufactured. Though there are many fibres which are susceptible to conversion into yarn, not all of these are suitable for making dress or furnishing cloths, and many of them have industrial uses which lie outside the scope of this book.

The qualities needed in a good textile fibre are as follows:

First, tensile strength, which is needed to take the strain of the various manufacturing processes and to produce a cloth that will wear well.

Second, uniformity of length, which facilitates spinning.

Third, evenness of diameter. Without this the yarn will be uneven, and the cloth will not weave smoothly. Occasionally a yarn is deliberately spun with an uneven diameter, caused by thickening it at intervals by what are called slubs or knops; this is an effect used for certain fancy cloths.

Fourth, the faculty of absorbing and retaining moisture. This is necessary for the dye processes; a fibre with low moisture absorption is difficult, and sometimes impossible, to dye, according to the degree of non-absorption inherent in it. This difficulty is one most frequently met in the synthetic fibres and in wild silk, the latter containing tannin which resists the penetration of moisture.

Fifth, abundance. There must be sufficient readily available raw material to make manufacture in quantity possible. Some of the more exotic fibres are comparatively rare, and for that reason they can only be manufactured in small quantities for high-priced luxury goods. Alternatively they can be used for special effects combined with yarns made from more abundant and therefore lower priced raw materials. But for any degree of mass production, the fibre must be available in large quantities.

Sixth, ease of cleansing. All raw materials need a certain amount of cleaning before the actual manufacturing processes can be begun. It is obvious that a fibre which can be easily cleansed from impurities is more economical in use.

The fibres most generally used for the manufacture of cloth fall into three different classes. (1) Animal fibres: (wool and silk); (2) Vegetable fibres: (flax and cotton); (3) Synthetic or artificial fibres, of which rayon is the one in greatest commercial use. There are other fibres which fall into these classes, but they are not suitable for the type of textiles with which this book is concerned, namely dress and furnishing fabrics.

The fibres mentioned have certain processes of manufacture in common, though there are modifications in some of the shared processes, due to the structure of the fibre to be treated. And all the fibres have certain specialized forms of treatment which are peculiar to them alone. These include various preparatory and finishing methods. The processes shared by wool, cotton, and flax are spinning, weaving, bleaching, dyeing, and printing. Silk is not spun, but made into yarn or thread by a process called throwing. It is woven, bleached, dyed, and printed. Waste silk is, however, cut into short fibres and spun. Rayon also is not spun; its continuous filaments are made by special processes described on pages 118 to 120. It is woven, bleached, dyed and printed. Staple rayons are however, cut and then spun by the methods used for wool, cotton and linen.

WOOL

The chief sources of supply for the wool used in Great Britain are England, Scotland, Australia, and New Zealand, and among these Australia supplies by far the greatest quantity. All fleeces contain two kinds of wool, long and coarse known as tops, and short and soft known as noils. In some breeds of sheep the long coarse hairs have been reduced and the soft short hairs developed—a breed of this kind is the Merino. In other breeds the long coarse hairs have been increased and the short soft hairs reduced—such a breed is the Scotch Blackface. All wool fibres have an outer cuticle made up of minute scales, which are only visible to the microscope. Sometimes these scales do not develop properly and this produces a defect in the wool called kemp; kemped wool is brittle and shows white patches which sometimes refuse to take a dye. Wool fibres have two characteristics which distinguish them from other fibres—these are the natural crimp, and the property of felting. The crimp of wool is important, for it is an asset in spinning as it helps the fibres to adhere as they are twisted around each other. Felting is caused by the shrinkage which occurs after repeated washing, the fibres closing up and becoming closely packed together. One of the very important properties of materials made from wool is that they contain innumerable tiny pockets of air which give good heat insulation. Wool also is very absorbent, and can hold a considerable quantity of moisture without feeling wet or clammy.

Wool is graded by a system called Top Numbers, which run from 100 downwards, and serve to indicate the grade of yarn which can be spun from it; for instance, 80's indicates a very fine wool, 32's a coarse wool. The principal breeds of sheep used for wool are: Lincolns, Leicester, Devons, Kents, Rosscommons, Border Leicestershire, South Downs, Shropshire Downs, Hampshire Downs, Dorset Downs, Cheviots, Herwicks, Blackfaced Scotch, Merinos, and Cross-Breds.

In addition to true wool, some fibres are also used which come from other animals. These are sometimes used alone to make woolly fabrics, or in unions with true wool. There are camel hair (of which the noils only are used for dress or rug fabrics, the tops being made up into industrial driving belts), alpaca, vicuna, mohair, cashmere, and horsehair. The wool obtained from slaughtered sheep is also sometimes used for blending with fleece wools to make medium type worsted, but no good quality cloth is ever made in this way for the wool from slaughtered sheep has a harsh handle, and neither spins nor dyes well.

Even with the enormously increased supplies of wool which the great sheep growing development in Australia has made available, there is sometimes an insufficient quantity of wool to meet all needs, so that recourse is had to what is known as recovered wool for lower grade cloths. For this, wool waste or old woollen garments, rags and yarns, are passed through a special machine which converts them to loose fibre which is then re-spun. There are four grades of cloths made in this way: mungo, shoddy, extract, and noils. Mungo is made from rags which have been woven with short soft wool; shoddy from rags woven with longer and firmer wool; extract from materials containing a mixture of wool and cotton and other vegetable fibre which is removed by carbonizing; and noils from the short waste fibres produced by the combing of wool. Such materials are always of second-rate quality, and do not wear as well as materials made from new wool. The first three types are generally mixed with a little new wool, but noils are generally woven alone. Materials made entirely of new wool are said to be made of virgin wool. Though wool is generally easy to recognize by its appearance and handle, there are to-day a number of long cut-staple rayon fabrics which very closely resemble it, so that appearance and handle are sometimes misleading. A simple test can be applied by burning a small piece of yarn or cloth; if it is wool it will burn fairly slowly with a smell like burning horn or feathers, and show very little flame, and a small bead will be formed at the edge of the yarn or cloth.

SILK

Silk is a continuous fibre which is produced by the silkworm in making its cocoon. Its use is traditionally supposed to have originated in China about the year 3000 B.C. The secret of sericulture was kept by the Chinese until the fourth century A.D., when silkworm eggs were smuggled into Japan and from there were introduced into India. There are two kinds of silkworm, the cultivated and the wild; cultivated silkworms produce the finest silk, while wild silk is rather coarse and irregular. Japan is the largest producer of silk for export, though Italy also exports a considerable quantity; Indian and Chinese silk is almost entirely used locally.

When the silkworm is ready to spin its cocoon, it secretes in its body a viscous substance called fibroin. This passes in the shape of threads through two glands which are near its mouth; immediately before being extruded from the worm, the two threads are cemented together and coated with a substance called sericin. While making its cocoon the silkworm constantly moves its head so that the cocoon takes an elliptical shape rather like a small sausage. In making the cocoon about four thousand yards of the double thread are spun. Only a very few cultivated silkworms are allowed to become moths—these being kept for the sake of their eggs which are needed for a new supply of silkworms. The majority of the cocoons are steamed to destroy the chrysalis which they contain.

To distinguish silk from other fibres, the burning test can be used; it burns quickly with hardly any flame, giving off a smell of burning horn or feathers and leaves a bead of brittle ash. Silk, if bitten between the teeth, separates cleanly, and does not crush as does cotton.

FLAX

Flax is an annual crop grown from seed, and the fibres used to make linen are found in the inner bark of the stalk, extending the whole length of this to its root. For this reason, the flax must be pulled, not cut, for if it were cut a large amount of waste would ensue. The long fibres cut from the centre of the stalk are known as cut line, and the shorter fibres which are removed in the preparation for spinning are called tow. The best quality flax is grown in Belgium and Ireland, Belgian flax being the finest in the world. Flax is also grown in very great quantity in Russia, in fact before the last war Russia grew more than all the other flax-growing countries put together; but Russian flax is not of the first quality and is not suitable for making the finest linens. Flax is also grown commercially in France, Holland, Germany, and the United States of America.

Linen burns fairly quickly, and leaves very little ash.

COTTON

The cotton plant is grown as an annual, and needs a warm, equable climate. It is bushy in growth and attains a height of from three to five feet. The cotton flower is pinkish-white, and when it dies it leaves a capsule which contains up to eight seeds. As the plant continues its growth, the seeds are covered with cotton fibres, each seed being completely enclosed by these, and the whole packed in what is known as a boll, which bursts when ripe and exposes a great tuft of fluffy white cotton. The bolls are picked after they have burst and it is usually necessary to go over a field several times as they do not all ripen at once. As the bolls are picked they are passed through a machine called a gin to remove the fibre from the seeds, and which also separates the very short fibres (which are useless in cotton manufacture) from the longer ones. The short fibres, known as cotton linters, are used in the manufacture of certain types of rayon.

This is the raw cotton, and is the stage at which it is shipped to the manufacturer. It still contains many impurities such as twigs, dried leaves, and earth, which have to be removed before the cotton can undergo the first processes of manufacture. As the cotton is very bulky, though light, it is shipped compressed into solid bales weighing about five hundred pounds.

The greatest producer of cotton in the world is the United States of America. Cotton is also grown in Burma, the West Indies, South America, Egypt, Russia, and the Far East. The finest of all cottons is that grown in the American States of Florida, Georgia, and South Carolina, and known as Sea Island cotton.

Cotton burns very quickly, with a smell like burning paper, and leaves practically no ash.

RAYON

There are three different kinds of rayon in general production to-day: these are viscose rayon, acetate rayon, and cuprammonium rayon.

VISCOSE RAYON

This rayon is made by first stacking sheet cellulose in frames and flooding it with a concentrated caustic soda solution. After the solution has completely and evenly penetrated the cellulose, the sheets are put through a hydraulic press. The sheets (which are now soda-cellulose) are next shredded into small crumbs and exposed to the air for two or three days. During this time the molecules of the cellulose are slightly broken down, so that it reacts more quickly to the next process, which is churning with carbon bisulphate. The cellulose crumbs turn yellow and then red-orange, and form a new compound: cellulose xanthate. When the compound is completely formed it is dissolved in a dilute solution of caustic soda which turns it into a viscous solution, so adjusted as to contain seven to eight per cent cellulose, and six to seven per cent of caustic soda. This solution (known as viscose) is not yet ready for spinning into fibres, for it does not flow smoothly. It is therefore left to stand at room temperature from four to five days, until tests show that it is of the right viscosity. It is filtered during this time, and also de-aerated, as air bubbles or suspended solids would interfere with the spinning. The viscose is then forced through a candle filter, and from this through the spinneret—which contains a definite number of holes—and it is then immersed in a coagulating bath which is mainly made up of sulphuric acid. This solidifies the viscose into fibres which are made into yarn by passing through a device called an eye, the fibres at this stage being sufficiently coagulated to remain separate and not to adhere to each other. The fibres are then led over a wheel from which they drop into a rotating centrifugal pot (receiving a slight stretching on the way) where they form into a cake and are at the same time given a degree of twist to strengthen them. Besides the sulphuric acid the coagulating bath contains other chemicals which modify the fibres, making them more supple and soft and more easily dyed. The viscose rayon as it leaves the centrifugal pot is still impure, and a little weak, so it is next washed, then treated with various chemicals to remove its slightly yellow tinge and make it completely white; after this it is once more washed. The rayon is finally dried in hot ovens or by passing it through heated air chambers.

Viscose burns like cotton, with a very bright flame, and leaves very little ash.

ACETATE RAYON

To make this, cotton cellulose is kneaded into a mixture of acetic acid, acetic anhydride and a catalyst. As a result of the reaction between the cellulose and acetic acid, caused by the catalyst, the cotton is dissolved and cellulose tri-acetate is formed. Water is now added to the reaction mixture, which is allowed to stand for a certain period, during which one half molecule of acetic acid splits off, and a cellulose acetate of two and a half molecules of acetic acid to one molecule of cellulose is formed. The reaction mixture is now diluted with water which causes the cellulose acetate to precipitate into a fibrous form not unlike cotton. After being thoroughly washed, it is dried, and then dissolved in acetone. This solution is then forced through spinnerets placed in small chambers through which warm air is circulated; this evaporates the highly volatile acetone, leaving solid filaments of cellulose acetate which are collected and wound on to bobbins.

Acetate burns a little like silk, melting and forming a globule of hard ash.

CUPRAMMONIUM RAYON

For this rayon, purified cellulose is kneaded with a cuprammonium solution (containing about three per cent copper and twenty-five per cent ammonia) until a clear blue solution is obtained, which is adjusted to contain about ten per cent of cellulose. The spinning operation resembles that of viscose, but the coagulating bath instead of being chemical consists of pure water; as the coagulated rayon is passed through this bath it is considerably stretched so that the resultant filaments are very fine. At this stage it is generally wound on bobbins, though sometimes it is collected in a centrifugal pot. The yarn is bright blue, owing to the presence of copper; it is next wound into skeins, and the copper is washed out with dilute sulphuric acid, after which the skeins are dried.

Cuprammonium burns like viscose.

SECTION TEN

PREPARATORY PROCESSES

Wool—silk—flax—cotton

ALL NATURAL TEXTILE fibres have to undergo certain preparatory processes before the actual manufacture of yarn can be undertaken.

WOOL

Cleansing processes: Natural grease and dirt must be removed from wool before the other processes preparatory to spinning can be carried out. There are four different ways of doing this; the first consists of passing a volatile solvent through the wool which removes the grease. The solvent is evaporated from the grease and passed through the wool again, and this process is then repeated twice, after which the wool is washed. In the second method, the wool is steeped in a bath of water, soap, and a weak solution of washing soda at a temperature of about 100° F., and is passed through several such baths until it is clean. In the third method, carbon dioxide is blown through the wool which is immersed in water. This separates the grease which rises to the surface of the water in a scum; the wool is then washed. In the fourth process the wool is washed in clear water, and then washed with soap and soda.

Wool is very apt to contain vegetable matter, such as burrs, which the sheep have picked up in grazing; the scouring processes do not remove these, and if a fleece is in this condition it is given a carbonising treatment which consists of steeping the wool in cold dilute sulphuric acid for two to twelve hours, according to how much cleansing of vegetable matter it needs. The acid is then squeezed out of the wool which is dried off at a temperature of 170° to 190° F. During the drying it is kept in the dark, because of the acid's reaction to light. The acid and vegetable matter are then washed out and a bath of weak soda, or ammonia, is sometimes added to neutralize any remaining acid.

Preparatory processes: These processes are planned to straighten out the wool and to form the fibres into what is known as sliver or roving, ready for spinning. They vary slightly according to the length and quality of the fibres and the type of yarn into which they are to be made. There are two kinds of cloth made from wool fibres—woollens and worsteds, and the final preparatory process before spinning is different for each; woollen yarns are carded and worsted yarns are combed.

WOOLLEN YARN

For woollen cloths the best type of fibre should have good felting qualities, be well crimped, and not more than four inches in length. If the wool after scouring should still contain any impurities such as sand or straw, it is put through a machine called the willow, which contains a spiked roller, which carries the wool round and throws it against a grid; the impurities drop through the grid. In some willows there are also beaters to knock off the dirt. To make the wool pliable and soft, and to prevent breakage of the fibres during carding, the wool is next sprayed with olive oil. Carding is the next operation, and for this three machines are used consecutively: the scribbler, the intermediate, and the finisher. These operate on the same principle, but with a difference in the size of the rollers and card clothing which are a part of the machinery. (This card clothing is a band of leather or linen in which are set a number of wire staples. This is placed around a roller, and the wire staples moving against each other while the wool is carried through, separate and loosen the fibres and bring them into some sort of parallel state.) The scribbler is the first machine used, and it turns the wool into a fleece, which is then fed to the intermediate machine, from which it emerges in the shape of a longer fleece. This is then put through the finisher to be made into a thin sheet of fibres.

From the finisher the thin fibre sheet is put through the condenser, the function of which is to divide it into bands of fleece. These bands are made into round slivers by endless leather belts, and the untwisted slivers are then wound on to bobbins. The wool slivers are now ready for spinning.

WORSTED WOOL

The object to be attained in the preparation of worsted is a round smooth yarn with parallel fibres which will not felt. The wool is put through the willow, if dirty, and oiled to make it supple, and is then passed through two carding machines called the breaker and the finisher, and from these emerges as sliver. The sliver is then passed through the gill box, which prepares it for combing. In the gill box, several slivers are doubled together and drawn out to the thickness of one, which helps to straighten out the fibres: sometimes the wool goes through three or four gill boxes before it is ready to be combed. This is the next process, and it removes all the shorter fibres below a given length, and also any foreign matter which may still remain in the wool, such as bits of burr or straw. Combing is done by mechanical metal combs and brushes, and there are several different types of combing machines in use. The slivers are now put through a machine called the backwasher, to remove the oil which was earlier sprayed on to it. The worsted is now ready for spinning, and is built on to bobbins by the roving frame which also imparts a little twist.

SILK

The silk cocoons are placed in bowls of hot water (which must be kept at a constant temperature) in order to soften the glutinous matter surrounding the thread. To reel off this thread all loose fibres are first removed and the end of the thread found; the threads are so fine that at least six cocoons must be unreeled together. Above the bowl of water is suspended a glass rod and the threads are passed over this, and from it through two pairs of eyelet holes fixed in bars; as the threads come through the eyelet holes they are wound into skeins. This is the raw silk, and is the stage at which it reaches the manufacturer. A considerable amount of tangling and breaking of the threads takes place during this operation; this is the waste silk, which is collected and cut into short staples which can be spun in the ordinary way on machinery similar to that used for cotton spinning.

FLAX

Cleansing process: After the flax has been pulled (either by hand or by machinery), it is necessary to remove the seeds so as to leave the stalks ready for the extraction of the fibre. The flax is first stacked and left to dry off in the sun, and the seeds are then removed by a process called rippling; for this a large iron comb is fixed in a board and the seed pods ripped off by passing the stalks through the comb.

Preparatory processes: The first stage in the freeing of the flax fibres from the stalk is called retting. This is done by steeping bundles of flax in stagnant or slow-moving water for two to four weeks, during which fermentation takes place. This causes the outer bark to decompose to some extent, and also loosens the fibres from the stalk. In retting, the flax is placed vertically under the water on a layer of reeds, with another layer of reeds on top, which are weighted to keep the flax bundles in position. To test the condition of the stalks, one or two are pulled out to see if the woody matter is brittle. Such tests are repeated until the condition of the stalks is right, for if they are left in the water too long they may become weakened and discoloured. In many modern linen factories, artificial retting is used: in this the flax stalks are steeped in tanks of warm water, and the operation takes only a few days instead of weeks. Another form of artificial retting is steam retting; in this, the stalks are placed in large closed chambers through which steam is constantly released. Dilute sulphuric acid is sometimes added to the water in tank-retting to speed up decomposition, and also to reduce somewhat the unpleasant odour which accompanies the process.

The next step is called scutching, and in this a bunch of flax stalks is held on a metal plate while wooden blades, rotating on a hub, strike it glancing blows which remove much of the woody substance and bark. Hand scutching is also very common, and in this the revolving wooden blades are fixed in a wall, the operator holding a bunch of stalks under them so that the moving blades strike them with glancing blows. This is a terrifying operation to watch, as it seems as if the operator's fingers must certainly be removed, but a good scutcher's skill in judging the speed of the blades and the exactly safe position for his hands, is almost uncanny, so casually is it done.

After scutching, the flax is next hackled in a machine which combs out all remaining particles of bark or wood as well as any short fibres which may still be left; the machine also divides the bundles of flax into separate fibres which are laid out straight and parallel to each other. This is done by a series of metal needles which act as a sort of comb to draw the fibres into position. Combing out is continued in a gill which finally makes the flax into a sliver. This machine has a series of moving belts fitted with sharp needles, and at the ends are drafting rollers to draw out the fibres and slip the slivers into a waiting can. The next operation is doubling several slivers into one, and drawing this out to the thickness of one sliver. The slivers are now made into roving and are ready for spinning.

COTTON

Cleansing processes: The raw cotton which arrives at the mill is in the shape of tightly compressed bales, and is still in a very dirty condition, full of impurities such as dried seeds, leaves, broken stalks, sand, and grit. When the bales are opened, the compressed cotton breaks apart in the shape of large hard lumps. These lumps of cotton are put into a machine called the bale breaker, which opens them up and begins the cleansing process. Next, the cotton is stacked up in horizontal layers and put into the hopper of the bale opener, which takes it in vertical section, so that the cotton is thoroughly well mixed. Other types of machines called hopper feeders, Crighton and porcupine openers, are also used for these two operations. The underlying principle of all these machines is the same, cleansing and loosening of the cotton by the combing or teazing action of moving spiked rollers or belts, and beating by rotating or striking parts, the cotton all the time being further extended and kept moving by the introduction of air currents into the machines. The next stage is passing the cotton through the scutching machine, which after still further loosening up the cotton, sends it out in a continuous flat band, forty inches wide, which is neatly rolled off into large bundles ready for carding. The last of the dirt and foreign matter is removed by carding, which also places the fibres into a roughly parallel position to each other. The principle of this carding machine is the same as that already described in the account of the preliminary processing for wool. For very fine cotton fabrics, the cotton is sometimes put through a combing machine after carding, which also works on the same principle as the combing machine for worsted which has already been described. By carding and, or, combing, the cotton has been made into slivers, which are now placed in a drawing frame which unites several of these together and draws them out to the thickness of one sliver; this drawing out of the slivers is called drafting. A further blending of the cotton thus takes place, and irregularities are smoothed out. The slivers are passed through the drawing frame several times, the number varying according to the grade of the cotton. The drawing machine works by a system of four pairs of rollers, between which the slivers are passed, each pair of rollers rotating at greater speed than the last. The cotton is not yet fine enough for spinning, and is also too loose to stand up to the high rate of speed involved in this, so it is put through another drawing frame, called a slubbing frame, which, as well as drawing, gives a slight twist to strengthen the cotton. This slight twist is given by leading the rope-like sliver through a flyer as it comes out from the last set of rollers, and from this it is wound on to a bobbin. Drawing is again repeated in another machine called the intermediate frame, and once more in another machine of the same type, called the roving machine. This completes the preparatory processes used before spinning for almost all qualities of cotton yarn. But if very fine yarn is to be made, the sliver is passed through yet another machine called the jack or fine roving frame.

SECTION ELEVEN

MANUFACTURING PROCESSES

Spinning—silk throwing—doubling—weaving

SPINNING

ALL TEXTILE FIBRES, except silk and rayon, must be spun before they can be woven; but *waste* silk, however, is spun. The processes for wool, cotton, and flax are very similar, but have variations dictated by the varying lengths of staple in the different fibres. The four systems are the ring frame, mule, cap frame, and flyer systems.

Cotton Spinning: The two types of machine spinning in use for cotton to-day, are the ring-frame or continuous system, and the mule or intermittent system. In the ring-frame method the roving is taken through a series of drafting rollers, the last pair revolving at greater speed than the preceding ones. The size of these rollers, and their distance apart from each other, is governed by the length of the staple being spun. From the drafting rollers the roving is next guided through an eye placed exactly over the spindle; the bobbin on which the yarn is to be wound is fixed to the spindle and both revolve together. Surrounding the spindle and bobbin is a metal frame which rests on the rail; this ring is flanged in its upper circumference and a small piece of metal, shaped like a loop and called the traveller, runs freely around the frame. The use of the traveller is to keep an even tension in the yarn and to guide it to the bobbin. The revolution of the spindle gives twist to the roving, and the amount of twist imparted depends upon the speed at which the spindle is kept turning; this ranges from 5,000 to 10,000 revolutions per minute, according to the fineness of the yarn which is being spun.

With the mule spinning system there is a fixed frame on which are placed the bobbins of cotton roving; on this frame are many rollers grouped in sets of three pairs placed in line, each pair rotating at progressively increasing speeds. Separate to the frame are carriages, which travel to and fro on the floor in front of it, these carriages support the bobbins and have numerous fine spindles on their heads. The length of travel for the carriage is about three yards. The spinning operation is done by drawing the roving from the bobbins, allowing this to pass between the drafting rollers as it emerges, and winding it on to the spindles at the head of the carriage; these spindles rotate steadily and give the roving a slight twist. The complete operation is done in three stages—in the first the carriage is moved away from the frame and draws the roving away with it—in the second the spindles rotate to give the yarn an additional twist—and in the third the carriage moves back and the spindles are rotated in such a way that the yarn is wound on to them without any further twist. These three stages are repeated over and over again, until the spindles are full and have to be changed.

Ring-spinning machines take up less floor space than mule spinning machines, and also have a larger output, so the majority of cotton spinning is done on them, though the mule system is used for certain types of yarn to which it gives special qualities.

Wool and Worsted Spinning: All four systems of spinning are used for wool and worsted spinning; the ring-frame and mule systems have already been explained in the paragraph on cotton spinning. The type of spinning system chosen for wool or worsted depends upon the length and structure of the staple.

The cap frame is a variant of the ring frame and is used to spin fine merino and cross-bred yarns; its action is rapid. The yarn is guided to the bobbin by a metal cap which is fixed to the top of the spindle, instead of by the metal traveller as in the ring-frame method. Also, instead of the spindle revolving as in the ring-frame method, it is fixed to the framework of the machine and it is the bobbin which, held in place by a hollow tube, revolves. It also moves up and down inside the cap to distribute the wool evenly upon its surface.

The flyer spinning machine is a slow machine and is used for some worsted yarns and for some types of hosiery and carpet wools. In this system, the cap or traveller is replaced by a two-armed piece of metal, which looks a little like a wishbone, and which is called the flyer. Sometimes the thread is guided through an eye in the head of the flyer and taken to the bobbin through another eye placed at the end of one of the arms; sometimes the thread is carried direct from the drafting rollers to the eye on the arm, and so to the bobbin.

The spindle revolves, taking the flyer around with it, the bobbin, resting loosely on the spindle, also takes part in this circular motion, but at a slower speed, which is imparted to it by the drag of the thread. The roving is put through drafting rollers at the same time, and as it is paid out it is taken up by the flyer; twist is given by the arm as it revolves with the spindle. The bobbin moves up and down inside the flyer so as to regulate even distribution of the yarn on it.

Flax Spinning: As the fibres of flax are smooth and long, they cannot be spun by either mule or ring frames, and the flyer system described on this page is always used. But in spinning fine linen yarns and warp yarns a variation, called wet spinning, is employed. In this, the roving is passed through a hot water bath, which softens the fibres and allows them to slip more easily over each other. This bath is placed between the roving creels and the drafting rollers, and the rovings passing through the rollers in this damp, soft condition yield more easily to their action. Ordinary dry spinning is used for coarser yarns and the spindle is run at 2,500 revolutions a minute, while in wet spinning its speed is 5,000 revolutions a minute.

Wet spun yarn must be dried off immediately it is spun or it will rot: for this it is reeled off into hanks and hung up in a heated room.

In the section devoted to preparatory processes, it was mentioned that the short flax fibres which are thrown out during the preparatory processes are called tow; these are carded in an engine of the same kind as that used for carding cotton, but with a considerably coarser carding card. After this the tow is spun on the flyer, but with certain adjustments made to it owing to the difference in the length of the tow staple.

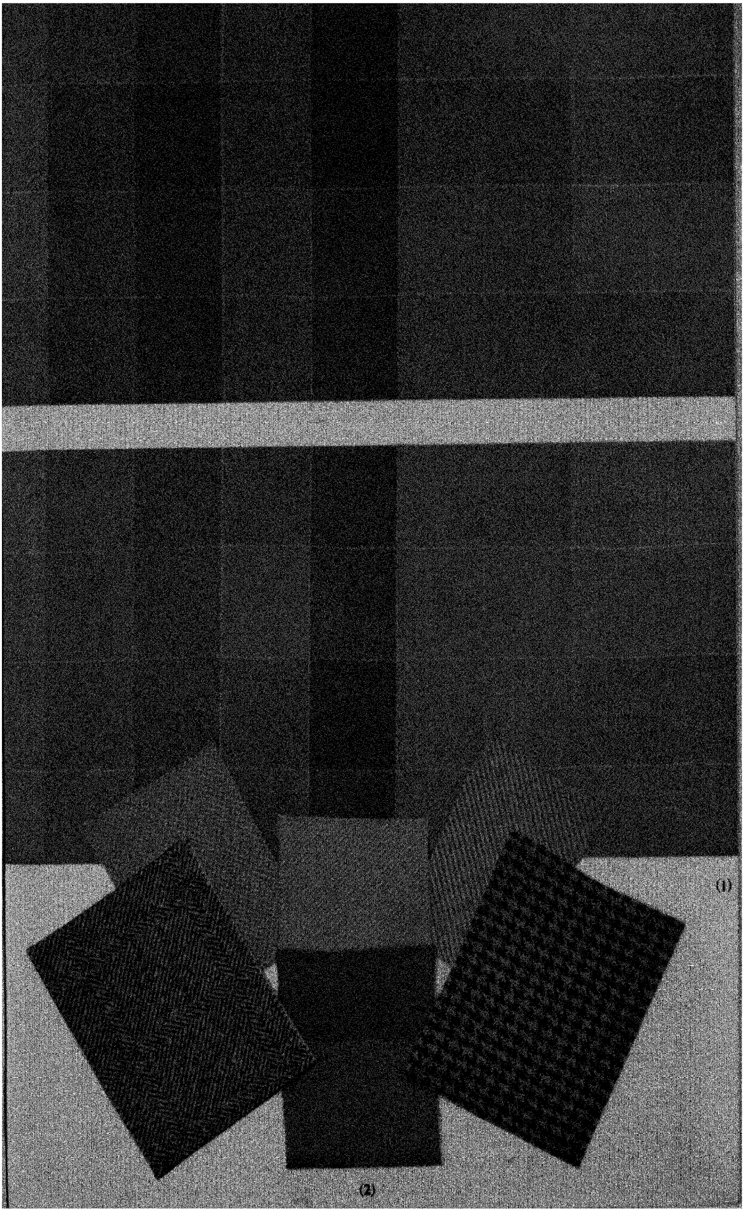
SILK THROWING

As the silkworm produces silk in a continuous filament this cannot be spun in the same way as are wool, flax, or cotton. Spinning is therefore replaced by a process called throwing, which consists in twisting the filaments together by means of a flyer. This has a vertically set spindle on which is fixed a bobbin on which several untwisted silk filaments are wound. This bobbin revolves with the spindle, on the top of which is a small cylinder which rests loosely in position and is kept in place by a screw cap. There is a groove in the cylinder round which a piece of wire is twisted, with its two ends bent into an S shape with loop eyes in each end. This is the flyer. Just above the spindle is a board on which is fixed the bobbin which receives the twisted thread. The untwisted filament is taken up from the lower bobbin through both eyes of the flyer and up to the horizontally placed upper bobbin. The lower bobbin being fixed to the spindle, revolves with it, and at a greater speed than that of the upper bobbin, so that the thread is "thrown" off faster than the upper bobbin can take it up, causing a certain amount of slack thread. This slack is taken up by the flyer, which running freely, twists the slack around at great speed before it reaches the upper bobbin. There is a guide eye in front of the upper bobbin which moves with a sideways motion and thus winds the twisted thread smoothly on to the receiving bobbin. The amount of twist given to the thread depends on the difference of speed between the two bobbins; the yarn thus thrown is called singles. The thrown thread is thrown a second time by exactly the same process, but with the twist given in the opposite direction.

When the silk has been thrown, it is set by steaming, and then graded for size and quality; it is then reeled on to large metal drums to be stored until needed. Thrown silk is sent to the

PLATE IV

(1) Two sample sections of alternative colourings for a fancy woven woollen clothing material. Each square shows a different colour combination from which lengths may be ordered. *S. H. Rawnsley Ltd.* (2) Group of ladies' woollen dress and coating cloths. Top left: two-colour fancy tweed. *J. J. L. & C. Peate Ltd.* Below this, a herringbone tweed with shadow check. *Gibson & Lumgair Ltd.* Centre top: a two-colour diagonal stripe tweed. *J. J. L. & C. Peate Ltd.* Below this two lightweight self-coloured woollen dress cloths. *S. H. Rawnsley Ltd.* Top right: two-colour diagonal stripe tweed. *J. J. L. & C. Peate Ltd.* Below this, classic shepherd's plaid check coating cloth. *Gibson & Lumgair Ltd.*


(1)
(2)

weaving mill as hard silk, or in what is sometimes called the hard state. This means that the gum inherent in the silk has not yet been removed. Silk is woven in this hard state, for the gum supports and strengthens the yarn during weaving; it is then removed as part of the finishing process for the woven fabric which is described in the paragraph on the degumming of silk in Section Twelve, page 135.

DOUBLING

All the spinning operations which have been described produce single yarns; many fabrics, however, are woven with two- and three-ply yarns or with fancy yarns with varying degrees of thickness. All these are produced by combining two or more spun threads, or threads of different thicknesses together, by the method known as *doubling*, which consists of reeling the separate yarns together without imparting any twist.

WEAVING

All textile yarns, including silk and rayon, are woven by the same methods, the basic principle of which is the interlacing of two sets of threads in a machine called a loom. The threads which extend throughout the length of the fabric are the warp threads and those which cross the fabric from side to side are the weft threads. Weavers, in speaking of cloth, often refer to the warp as "ends," and to the weft as "picks." Cloth is woven in lengths of from forty to a hundred yards according to its type; the warp has the greatest strain to bear during weaving, so this is made of the strongest yarn. The weft, having less strain, can be of an inferior grade of strength, which is chosen in relation to the strength of the warp threads. The basis of all weaving, both hand and power, is a shuttle which contains the bobbin on which the weft thread is wound, and an action which lifts every alternate warp thread, so that the shuttle can be thrown straight across, without the trouble of having to interlace it through by hand. Lifting alternate warp threads gives plain weave; the action of lifting warp threads can be varied to give different combinations to that of the alternate lift.

The first step in weaving is the preparation of the beam; on this the warp threads are wound side by side as they will be in the loom; these warp threads must be of an appropriate length for the desired woven length of the fabric, and allowance must be made for the slight undulatory character of the threads when woven into fabric. Before preparing the beam the warp threads are sized with a thin film of starch paste, or of gum, to give them strength, and then dried. Meanwhile, the weft threads have been wound on to small tubes to form what are known as cops, each shuttle enclosing one of them.

When the beam has been prepared, it is placed at the back of the loom; the threads drawn from it, are passed over the back roller and turned around two rods called the lease rods. These control the tension on the warp threads. In the centre of the loom are hung the heddles or healds, which are loops in the centre of which is an eye, with a warp thread drawn through each of these. The odd heddles are controlled by one harness and the even heddles by another, and they rise and fall automatically in alternate motion. The opening of the two sets of warp threads caused by this movement of the healds is called the shed and the movement of the healds is described as shedding. Towards the left of the loom is the sword, which works on a pivot, the top moving backwards and forwards in an arc; at the top of the sword is the sley across which the shuttle is thrown. And just behind the sword is the reed, which is something like a comb and made of narrow strips of metal placed vertically in a frame; the warp threads pass through the openings between these teeth. One, two, or three warp threads can be arranged to pass through the reed; from here the warp threads are carried under a small roller to keep the tension even; the warp thread, and, as it progresses, the woven cloth, are carried over the breast beam to the cloth beam. There are five movements in plain loom weaving; shedding, when the healds move up and down and part the warp threads; picking, which is the movement of the shuttle across the warp propelled by the action of the picking strap or stick (there is one to each side of the loom); beating-up, which is the action of the sword moving forward to allow the reed to beat-up the weft thread close to the last weft thread deposited. The next two movements happen together, and in these the woven cloth is taken up by the cloth beam and the warp beam releases enough warp to take the next pick. The action is continuous so that the warp beam steadily releases warp threads as the cloth beam takes up the woven cloth. The loom described is the plain power loom; the basic principles of the hand loom are the same, but in this the shuttle is thrown by hand, and the heddles are operated by foot treadles which lift them alternately.

In the plain power loom it is impossible to change the pattern being woven, once this has been set by the arrangement of the healds, until the length of cloth is finished. To vary patterns during the course of weaving, a loom called the dobby is used; or dobby attachments can be fitted to plain looms. But only the very simplest of figures are possible with the dobby and for the more elaborately patterned cloth such as a brocade and damask, a loom called the Jacquard loom (after its inventor) is used. The Jacquard has a harness in the centre of the loom with an eye at the bottom of each harness cord, through each one of which a warp thread is passed. Several of the harness cords are tied to a wire in the upper part of the loom, the top of each wire being shaped into a hook, each hook controlled by a needle fixed into it. The needles press against a metal box, which is known as the *griffe;* this box is pierced with a series of regular holes which would allow the needles to rise all at the same time except for the control exercised by a sheet of stiff card which is placed between the *griffe* and the needles. This card is perforated in a series of holes, which look very much like the punctures on a pianola roll, and fulfil very much the same function. As the needles move up they pull with them the hooks, which are attached to the harness cords, and so raise a number of warp threads. Through this shed, the shuttle is thrown. There are a series of these cards which are strung together, each card completely controlling one pick of the weft. The cards are changed by a quarter turn of the *griffe* which in turning brings a fresh card into position.

Not only is the modern loom power-driven, but there are also a variety of automatic devices used in connection with it, such as the automatic replacement of empty shuttles without the loom's having to be stopped, and attachments which stop the loom if either the warp or weft threads should break. One man can look after four automatic looms, and the preparation of the warp beam is also to-day a machine operation.

SECTION TWELVE

SECONDARY PROCESSES

Cleansing of cloth and yarn—degumming of silk—bleaching—waterproofing—dyeing—printing—finishing and special processes

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WHILE IN THE loom stage, newly woven cloth of any description is far from attractive. It is often harsh and stiff, contains impurities, either natural or added to help the processes of manufacture, and is often soiled and oil-stained. Unless it has been woven from dyed yarn it is also a very unattractive greyish or brownish colour (according to the fibre from which it is made) such cloth being called grey or brown cloth. (Grey cloth is the usual Lancashire and northern term, while brown cloth is more often used in the south and always for linen.) It is therefore necessary for the cloth as it comes off the loom to be sent to the finishers for a long series of intricate processes to bring it up to its final state. To anyone not used to dealing with loom stage fabrics, they are in this state practically unrecognizable for what they really are.

CLEANSING OF CLOTH AND YARN

The first process which cloths undergo in finishing is cleansing; for this a choice must be made of agents which will do the cloth as little harm as possible, and yet be capable of removing all dirt and impurities. As the different fibres all have characteristic reactions of their own to various purifying agents, each different one has its own specialized scouring and bleaching processes.

In addition to cleansing from impurities the natural colouring matter of the fibre has also to be bleached out, if the finished fabric is to be white or any pale colour. Apart from the cleansing and bleaching of woven fabrics these processes are also applied to yarns which are to be dyed in the hank. Whether these yarns are treated in hanks or in cheeses or wound on perforated rollers, depends on the fineness of the yarn, for if the yarn is very fine it will get badly tangled if treated in the hank, whereas a coarser yarn will do very well under this method.

Wool yarns are most often scoured in large shallow tanks filled with warm, soapy water. The skeins are carried from tank to tank between two endless upper and lower belts, which are made of spaced wooden lathes so that the soapy water can circulate freely through them, the yarn being held firmly in position between the upper and lower belts. As the skeins come out of one tank, the dirty water is gently squeezed out of them, so as to avoid fouling the water in the next tank. The same method is also used for scouring cotton and linen, and is a useful one, as by it large quantities of yarn can be quickly dealt with. Smaller lots of yarn are scoured by hanging the skeins on smooth wood or stainless metal rods, which have their two ends resting on either side of a long wooden tank. As the rods rest on the tank the skeins are completely covered by the soapy water. At intervals the rods are moved from one end of the vat to the other, the hanging skeins being in this way swished through the water, the skeins being at the same time partly turned or completely inverted, so that the part which has been hanging over the rod also gets washed. Another method is to use a machine such as is used for dyeing. This is a long vat filled with the cleaning liquor, over which there is a framework which carries a number of rods from which the skeins are hung. This framework can be lowered so as to completely submerge the skeins in the cleaning fluid. The water is kept automatically moving, so that it flows constantly through the skeins; at the end of the process it is drained off, and the vat filled with clear water for rinsing.

DEGUMMING OF SILK

The woven silk still in its hard silk stage is boiled in a weak soap solution to dissolve as much of the gum as possible, after which it is rinsed. When the gum is dissolved from the silk this loses an appreciable degree of weight, which increases its cost. To obviate this, various methods of weighting the silk have been devised; in these certain inexpensive chemicals are deposited in the degummed silk, which not only increases the weight but also thickens the fibre. If the weighting is not excessive the silk will keep its strength and softness; over-weighting weakens and stiffens it. Pure, unweighted silk is the highest quality silk.

BLEACHING

WOOL

Wool can be bleached by two different methods, or sometimes by a combination of both of these. One method is called stoving, and in this the material is enclosed in a closed chamber where it is exposed to the fumes of burning sulphur. The bleaching is done after scouring and preferably while the material is still slightly damp. Both wool yarns and woven fabrics can be bleached by this method. The white obtained is not permanent and the wool gradually reverts to its natural colour as the garment is worn. The second method is to steep the wool in a vat of hydrogen peroxide solution in the same way as that described in the paragraph on the bleaching of cotton, on page 137.

SILK

Silk can be bleached by either of the two bleaching processes described on this page and on page 137.

LINEN

The oldest and best method of bleaching linen is by exposure to sun and air. The traditional method was to first boil it in lye, derived from burnt seaweed, and then to spread it out for days on a grass bleaching green to endure the effects of sun, air, and rain. Artificial watering was also used. The boiling and grassing were repeated many times, and the linen was then treated with buttermilk. To-day, grass bleaching is still much used, but certain chemicals are substituted for the lye and buttermilk, and the exposure to sun and air is shorter. There are at least twenty to thirty slight variants of modern bleaching methods, and grass exposure is not always resorted to.

COTTON

The cotton cloth is first thoroughly scoured. It is then placed in a vat containing a two volume strength solution of hydrogen peroxide, together with a small quantity of sodium silicate or sodium triphosphate. Before immersing the fabric, the liquor solution is raised to a heat of 50° C. and the fabric is tightly packed in. Six hours immersion are allowed, and the solution is allowed to cool gradually during this time. The cloth is then taken out and well washed, when it is found to be a pure true white. A cheaper form of bleaching is done with a solution of active chlorine.

RAYON

Rayons are usually white by the time that the fibres have been manufactured, so that no bleaching operation is needed to improve the whiteness; but sometimes a form of bleaching is necessary to rid the fabric of dirt which it has acquired during the process of weaving. Also, if the rayon is used in a union material with other yarns, which require bleaching, it will have to undergo this process. The type of rayon determines the safe bleaching process, and in any case the treatment must be gentle, or the rayon will become harsh.

WATER-PROOFING

There are several types of water-proof finishes which can be applied to wool, cotton, silk, or rayon. Most of these methods have been made obsolete by the new method of impregnating light fabrics with a solution of synthetic resin. Coating of fabrics with a solution of rubber is also much used.

DYEING

The dyeing of fabrics or yarn is a subject which can only be briefly dealt with in these pages, for not only is it intricate, but it is also highly technical. Successful dyeing of a fabric requires the use of a dye for which the fibre from which the fabric is made has a special affinity. The dye must be applied with absolute evenness and allowed to penetrate the yarn or fabric completely. Every part of the fabric or yarn must be exposed to the same amount of dye, which means that the dye bath must either be in agitation or that the material or yarn must be moved about in it.

Dyeing to-day is done with a range of pure standardized dyes which are derived from coal tar and other substances. The coal tar dyes of to-day were discovered by accident by a chemist called William Perkins in 1856. Perkins was endeavouring to make quinine synthetically, and instead of this produced a tarry product from which he found he could extract a mauve colouring matter which proved to be a suitable dye for silk and gave fast-to-light shades. Encouraged by the Perth firm of Messrs. Pullar, he continued experimenting and finally set up the first aniline dye manufacture. Besides his original mauve he discovered several other dyes. Perkins' work was continued by other chemists and to-day the full range of synthetic dyes available for dyeing materials is between two and three thousand. This huge range of dyes is classified according to affinity for the different textile fibres. Thus, there is a range of dyes for cotton, for linen, for wool, for silk, and for rayon, some of which are suitable for more than one of these fibres.

To ensure the complete absorption of the dye by the material or yarn it is not enough only to move it about in the dye, it may be necessary to add an acid or salt to the solution to help the dye to penetrate, or warming or boiling the dye liquor may give the same effect. The method used largely depends on the dye and the material to be dyed. Again, if the dye is not readily soluble, and therefore the material might be dyed unevenly, an addition of soap or ammonia or sodium carbonate can be used to help form a complete solution.

Should it, for some reason, be desired to use a dye for a fabric for which it has no affinity, this difficulty can be overcome by the use of what is called a mordant. These are colourless substances, generally metallic, with an affinity both for the particular dye and for the fabric. Here the method is to treat the whole fabric with such a mordant and then to dye it in the ordinary way; the dye will then take perfectly.

Some of the most important dyes used for fabrics are insoluble in water; dyes of this kind are the vat and sulphur dyes. Vat and sulphur dyes, owing to their insolubility in water, are among the fastest dyes in use. Such insoluble dyes can be reacted with a reducing agent which causes it to form a leuco compound. The reducing agent for vat dyes is sodium hydrosulphite, and the leuco compound formed by the combination of the chemical and the vat dye is soluble in dilute solutions of caustic soda. Materials immersed in this leuco compound have an affinity for it, so that they absorb the dye. But the material when withdrawn from the leuco solution may, for various reasons, be quite colourless even though the dye has been completely absorbed by it. The colour in the dye is then developed in various ways, such as chemical treatments or by oxidization caused by exposure to air.

Naphthol dyes are used in a different manner; these are also very fast dyes and naphthol red gives a very brilliant tone on cotton. In this method of dyeing, two or three components are combined with each other. If, however, they are directly compounded with each other the resultant compound is insoluble in water. So a solution of the first component is applied to the material and the material is then plunged in a solution of the second component which enters immediately into the fabric before the first component has had time to be washed out of it. The dye is actually formed inside the fibres.

Fastness to light and washing can also be improved in some dyes by treating the fabric, after dyeing, with a metal salt. Solutions of copper sulphate are used in this way for certain cotton dyes and chromium salts are used for greater fastness in some wool dyes. The fact that some fibres have an affinity for a certain dye and others have not, is used for a very interesting form of dyeing known as cross dyeing. The material to be dyed in this way is woven from these two different fibres and is then either dyed by immersing it in two baths (one after another) of the two different dyes, or by combining the two dyes in one solution. Whichever method is used the result is the same; each fibre absorbs the dye for which it has an affinity and resists the one for which it has none, and the material is therefore dyed in *two* colours. All sorts of fancy effects can be got in this way: stripes, checks, fancy broken weaves will all have their character emphasized by the double colouring. Another method is to dye a white union material in only *one* of the dyes; the result then is a mixed fabric in white and one colour.

The early dyeing of rayon, when these materials first appeared, was extremely difficult, but long and intensive experimental work has resulted in making the dyeing of these as successful as that of the other fibres. Staple-cut rayon yarns often have a dye incorporated in the material from which they are manufactured, and can be woven and finished in their own colour or over-dyed after weaving. Esterified viscose (sometimes called immunized viscose) is used for decorative effects, as the immunizing process destroys the affinity of the viscose for direct dye stuffs.

A type of dyeing much used to give a pale tinted ground (almost always afterwards printed with a design) is called padding. In this method, the material is not immersed in a dye liquor, but is instead, run through a mangle which has a trough filled with coloured dye. The fabric first passes through this trough and then through the mangle and emerging from this, is led over a set of drying cylinders. This method produces very delicate pale tints.

There are several different methods of immersing the yarn or fabric in the dye. Small quantities of yarn are often dyed in a tank, the hanks of yarn being hung from rods which rest on the side of the tank. The yarns only extend down half the length of the tank, and are periodically moved down to the other end of this, and the position of the hanks on the rods reversed. In this way, the yarn is made to move through the dye liquor and every part of it receives treatment. The method is exactly the same as that sometimes used for scouring yarn described on page 135. But for large quantities of yarn other machines of a more complicated and semi-automatic type are used. In these the suspended yarns are hung on rods which can be made to rotate and which are fastened to a frame which moves up and down. As the frame is lowered towards a fairly shallow trough of dye placed beneath it, the rods begin to revolve and the lowering of the frame dips the yarn into the dye. The rods continue to rotate and the direction of this movement is changed from time to time. In this way the yarn is kept in constant agitation in the dye and takes it up evenly.

Woven fabrics are dyed in several ways, the two most usual being the jigger method and the winch machine. The jigger method consists of a series of rotating rollers by means of which the fabric is drawn backwards and forwards through the dye bath, which is a V-shaped vessel. In the winch machine method the dye bath has a straight back and a curved front, and above this is a large horizontal roller. The materials to be dyed are threaded over this roller alongside each other, but not touching. The roller then revolves, and draws the fabric out of the dye between guiding pegs over a guide roller, then over the central revolving roller and so back to the dye. The process is continuous so that the material is constantly moved about, and all parts of it receive the same length of treatment, usually about one or two hours. All dyed fabrics and yarns are rinsed after dyeing and excess moisture is generally removed by hydro-extraction, the final drying being done by hanging the fabric over frames.

PRINTING

There are three methods of textile printing: hand block printing, roller printing, and screen printing. Of these, roller printing is the most widely used, though the use of screen printing is very greatly increasing. Roller printing is the fastest method, block printing the slowest, and screen printing, which is a combination of mechanical and hand methods, is moderately swift and gives beautiful results. Block printing is only used for the best quality dress and furnishing materials, for its slowness makes it a costly process.

Block Printing: For this form of printing the material is laid out flat down the length of a long wooden table which may be as long as forty feet: it is lightly pinned to hold it from slipping out of place, which would spoil the registration of the blocks. The pattern is applied by means of beautifully hand-carved wooden blocks, which are rubbed on to a dye pad and pressed by hand upon the surface of the material. Each block is used for one colour only, and the head printer generally has an assistant working with him. Down the two selvedges of the material are little pegs to guide the placing of the blocks in the repeats. The laying of each block in position is a very skilful operation calling for a very steady hand and accurate eye. The smaller blocks are applied only by hand pressure, larger and heavier blocks are often tapped with a wooden mallet to impress the pattern more deeply. There is practically no limit to the number of blocks which can be used in this method; eight colour prints are frequent, and up to fourteen colours nothing unusual. Very beautiful single-colour prints are also made in this way. Designs printed by this method have great liveliness owing to the tiny irregularities which are inevitable in any hand process; that is not to say that registration is inaccurate in hand block printing for it is not, and a good block printer can perform miracles of accurate placing in the most intricate designs. But still there is that indefinable quality which always accompanies anything skilfully produced by hand.

Roller Printing: This type of textile printing is done with engraved copper cylinders in a rotary printing machine. There is a separate roller for each colour to be printed. In the printing machine there is a large central roller made of cast iron, the printing rollers being arranged round this and pressing against it. This central roller is covered with a blanket to give it resilience, and this is protected from absorbing too much dye by a piece of plain cotton cloth. The fabric to be printed is carried round the padded central roller; the printing rollers are so placed that each one can run lightly over the surface of the cloth. The dyes are in small troughs immediately below the printing rollers, and are conveyed to the appropriate roller by a furnisher roller which revolves in the dye trough with its upper half projecting and touching the surface of the printing roller it feeds. A long knife called the "doctor knife" presses against the printing roller to remove any excess dye before the roller actually touches the cloth. There is another knife, called the "lint doctor," which scrapes the roller as it comes away from the cloth to remove any bits of fluff or thread which would blur the outline of the print if they were allowed to remain. The whole of the mechanism is worked by power; as the rollers apply the colour to the cloth this moves forward and leaves the central roller and is afterwards led through drying and steaming chambers. Up to fourteen separate colours can be printed on this machine, and extra colour effects are also possible by overprinting. This type of machine is used for both dress and furnishing fabrics. The different types of prints which can be produced on such a machine are as follows:

Direct print: A multi-colour print on a white or very palely tinted ground.

Blotch print: A white design showing against a coloured ground, produced by printing the ground all over and leaving the white ground free to make the design.

Discharge print: Another coloured ground with a white design, but produced differently to the blotch print. The fabric is first dyed all over with the ground colour, generally a rather dark one. Then it is printed, not with dye, but with a chemical which will bleach or "discharge" the ground wherever it touches it. The discharge often does not act at once, but is developed later, the fabric, after drying being passed through a heated chamber in which the air is kept moist by steam. The warm, humid air causes the discharge to act.

Coloured discharge: There are some dyes which are not affected by the discharge chemicals; one or more of such dyes are mixed with the discharge and then printed. When the cloth passes through the damp heat of the steam chamber, the discharge removes the dyed ground wherever it touches it, but the dyes mixed with it are not affected, and remain on the fabric, giving a multi-colour design on a coloured ground.

Resist print: For this the fabric design is printed with a paste which will prevent the fixation of certain dyes. The fabric is then dried and padded all over with a colour paste which contains one or more of these dyes. When the fabric is steamed and dried the padded dye is only taken up in those places where the resist has not been printed. The result after washing is a white design on a coloured ground. Coloured designs on a coloured ground can also be made by the resist method: some dyes are not prevented from being fixed by the resist, so one or more of these can be mixed into the resist paste and remain when the other dyes have been washed away.

Discharge and resist prints are mostly used for rayon and silk dress goods and the higher priced furnishing cloths. Blotch and direct prints are the most usual forms of printing for the medium and low-priced cretonnes and other cotton furnishing and dress cloths.

There are two types of printing which give a reversible material, and these are called the Duplex prints and push-through prints.

Duplex print: This is done on a special large printing machine: as the cloth moves away from the printing cylinders it is reversed and brought around again over the cylinders which then print the same design on the wrong side of the cloth. The accuracy of this machine is extraordinary for the most intricate prints will be exactly registered on both sides of the cloth. This is a method used for the finest types of furnishing materials.

Push-through print: This is a method of producing a reversible print on a low-priced furnishing cotton. The printing rollers are applied with extra pressure which pushes through a slightly blurred impression on the wrong side of the thin cloth.

Roller printed fabrics are always steamed after printing to fix the dyes; after the steaming they are washed to remove any loose colour or chemicals.

Screen Printing: In screen printing the fabric is stretched out down a long wooden table as for block printing. The design is applied by silk mesh screens fixed in a wooden frame. There is a screen for every colour to be printed. The mesh of the screen is covered with an insoluble varnish, except in those parts of it which correspond to the colour in the pattern allotted to that particular screen; starting at one end the screen is placed on the fabric and, with either a brush or spray gun, the colour is forced through those parts of the screen which have not been coated with varnish. The screen is then lifted and put down on the material where that part of the pattern next occurs, continuing thus down the whole length of the fabric. The other colours are applied in the same way, considerable care being necessary to register them correctly. Each colour screen has its own printer, each colour thus following on the last much more swiftly than in block printing. There are very delicate effects of shading and blurred edges which can only be done by this method. The printed fabric is generally steamed after the printing is complete. This method is much used for good class rayon and silk dress and furnishing fabrics. As the screens are much lower in cost than the copper rollers of the roller printing machine, it is an economical method by which to execute short runs and special orders. Up to sixteen colours can be printed in this way.

The finishing processes for printed fabrics include washing, extracting excess moisture (generally in a hydro-extractor unless the fabric is too delicate for this), drying and stentering to restore original width.

FINISHING AND SPECIAL PROCESSES

WOOL

Wool or worsted cloth finishing comprises many complicated processes which vary according to the final surface which the cloth is to have. Some cloths undergo a full series of them, others only a selection. For that reason it is difficult in a work of this length to give the full cycle for each different cloth and only the more important finishing processes for wool and worsted cloths have been described though there are several minor ones which are sometimes used for special cloths. For convenience of reference these processes are listed, not in order of application, but alphabetically.

Anti-shrink processes: Though the shrinking and felting qualities of wool have always heretofore been an essential part of its manufacture into cloth, there has long existed a desire for a wool which would not shrink in use after manufacture. The first method for producing non-felting wool was introduced into Great Britain some fifty years ago and is known as the wet chlorination process. In this, solutions of sodium or of calcium hypochlorite with the addition of acid, are used. But it is only quite recently that there have been any substantial improvements in this particular process, which is still extensively used. In 1933 the Wool Industries Research Association patented a new process of dry gaseous chlorination which is a great improvement upon the old wet process, and this new method is now in large use in this country. By it, loose wool, yarn, tops and garments can all be treated. It requires rather more careful control than wet chlorination and a somewhat more expensive plant, but gives far better results; the cost of the chemicals used—chlorine gas and alkali—are cheap. In the last few years other methods have been developed in this country, both by the Wool Industries Research Association, and by commercial firms, all of which are now in successful industrial use. These methods include the use of sulphural chloride in white spirit (Drisol process), inorganic or organic bases in mixtures of alcohols and inert solvents (Alkali method), a wet method using the enzyme papain, derived from dried paw-paw juice, and which is relatively inexpensive (Perzyme process), and dry chlorination followed by a modified papain treatment (Chlorzyme process).

These processes give the woollen manufacturer a new, non-felting wool which has different dyeing properties to untreated wool; they can be applied to wool in any form. Apart from the advantages of woven or knitted garments which can be washed or wet without fear of shrinkage, the new wools offer many interesting possibilities for the production of new designs in cloth. A cloth made from both treated and untreated wools can be given an extra scouring or be lightly milled, when the untreated wool will thicken or felt, and the treated wool remain quite unchanged. Or different colour effects can be achieved by dyeing a cloth made of treated and untreated wool in a single dye bath; as the treated wool will take up the dye more quickly than the untreated wool, the result of such a single dye bath would be a tone and tone effect. Such an effect could only otherwise be achieved by using yarns separately dyed in two shades. The papain process gives wool another useful quality as well, for it leaves it very soft and silk-like in handle, and completely eliminates this fibre's usual unpleasant "tickle."

Calendering: Heated rollers press the cloth to make it uniform, and to break up any lumps which may be in it.

Crabbing, Decatizing: These finishes are intended to set the design of the woven cloth and prevent irregular shrinkage. The cloth is evenly wound on what is known as a crab roller which revolves in a tank of boiling water. The cloth to be treated is protected by a cotton wrapper secured at the ends. After passing through the boiling water, an end of the cloth to be finished is loosened, and carefully wound on a galvanized and perforated hollow roller, the whole length of cloth being gradually transferred from one roller to the other. Steam is now carefully blown through the hollow roller, and the cloth on removal is slowly cooled before being folded.

Cropping: The raised fibres of the cloth are sheared off by revolving circular knives to give a perfectly even finish.

Cuttling: A term used for folding cloth.

Fulling or Milling: To produce a dense cloth, the wool's property of felting is utilized in this process, which involves friction, moisture, and heat. The milling is done by a machine which beats the cloth with heavy wooden mallets while it is immersed in a bath of soapy water. The heat element is produced by the friction of the wooden mallets.

London Shrunk: This is a process designed to remove stretch in the fabric so that it will not shrink when it is later pressed by the tailor in making up, or if the wearer of it is caught in a shower of rain. It is not a permanent anti-shrink finish and will not prevent the cloth from shrinking or felting if it is washed. The process consists in interleaving the woven fabric with a thin damp wrapper and leaving it undisturbed for about twelve hours; it is then dried without tension and pressed.

Mending: Any broken or missing threads which may have occurred in weaving, are repaired.

Perching: When the cloth is removed from the loom it is placed over a roller and examined closely for any imperfections such as hair, knots, or burrs and for missing threads.

Picking and Burling: All irregularities which may have occurred in the weaving are picked out from either the back or the face of the cloth.

Rigging: Folding a double width cloth down its centre with selvedge to selvedge.

Roll boiling: This is used to give a bright and glossy face to a cloth which is afterwards pressed. To roll boil, the cloth is wound on to either a wood or iron roller, covered with a cotton wrapper and then put into a cistern of water, together with other rolls of cloth, but each roll kept upright and prevented from touching its neighbour. Steam is then blown in and the water brought to the boil and continued for four to five hours. After boiling the rolls are carefully lifted out and set up endways to cool.

Scouring: The water for this should be as soft as possible, and the cleansing agents used with it vary from cottonseed-oil soap for heavy work and mild white soap for worsted, soda ash as free from caustic as possible, pearl ash, ammonia, and refined blue fuller's earth. The scouring is usually done in a "dolly" washing machine. Drying is done by hot air, care being taken to leave a little moisture in the cloth.

Singeing: This is applied to the surface of cloth in the grey state which is to be piece dyed; it is not advisable after the cloth has been crabbed or dyed, as it very appreciably alters the handle, and in the lighter shades also affects the colour of the dye. Singeing is used to clear away loose fibres from the surface of the cloth which helps to prevent felting.

Teazling: This is a method for raising the nap of a cloth and teazle heads give the best results, though steel hooks sometimes replace these.

Tentering or stentering is done while the cloth is in a damp state; it is stretched over a moving frame which holds the cloth tightly in its length while stretching out the width. The frame with the cloth on it is passed over heated plates or through a hot chamber to dry, and set to the right width.

SILK

Owing partly to the nature of the fibre, and partly to the soured bass-soap used during the dyeing operations for it, silk undergoes special finishing processes unlike those given to other fibres, with the exception of rayon. When the silk has been removed from the final bass-soap bath it is dull and dirty looking, and quite lacking in lustre. To restore the lustre, a brightening treatment is used: this consists of immersion in an acid bath, those most generally employed being solutions of sulphuric acid or of acetic acid. For special finishes, solutions of tartaric acid or of citric acid are also used. The choice of acid is determined by whether the object is simply to restore lustre and colour to the silk, or to give it, in addition, the quality known as "scroop." This quality, not naturally inherent in silk, is difficult to describe in words, but its name is perhaps sufficiently descriptive. If the silk is to be quite soft and without "scroop," the brightening process consists of the use of basic alum or basic aluminium acetate. The temperature of the brightening baths is also determined by the character of the silk and the degree of brightness desired. After the brightening bath, various dressings such as solutions of fats, oils or paraffin wax in benzine or benzole, are used. This dressing is particularly necessary in the case of heavily loaded black silks, and serves as a coating to protect them from the air. Highly loaded silks are also sometimes sized. All these dressings are applied to the cloth by passing it through rollers which revolve in the finishing mixture.

The finishing mixture is not removed from the cloth, which is next stretched out in a tentering frame, and dried off while it is still stretched taut. The same finishing treatments are given to white silk after bleaching. The characteristic appearance of silk crepes is caused by the fact that both the warp and weft threads used to weave these shrink during the final bleaching or dyeing operations. This shrinkage is controlled by stretching in a tentering frame during drying off.

LINEN

The finishing processes for linen are almost the same as those used for cotton.

COTTON

There are many finishing processes for cotton, only those most generally used being described.

Anti-shrink finish: There are two methods for producing cotton fabrics which will not shrink when washed—the Rigmel process and the Sanforizing process. Both of these make use of the same basic theory—the shrinkage of a fabric to a given length, which is then set by the application of heat and pressure. In Rigmel finish the method consists of drawing the cloth over a roller which is covered by a thick blanket; as it comes off the roller, and begins a straight path, pressure is applied to it by a heated iron. Owing to the thickness of the blanket the outer side of this is elongated by the curvature of the roller and the cloth which is pressed to it conforms to the blanket's length. As the blanket begins the straight path it returns to its original length but the cloth starts the straight path in a slightly puckered condition. At this precise moment the application of the hot ironing plate sets the cloth into the contracted state it has thus acquired.

In Sanforizing a similar method is used to contract the cloth but instead of being set into this state by a hot iron, it is gripped between a blanket and a steam-heated metal cylinder. The action of passing around this heated cylinder sets and smooths the cloth into a permanently contracted state.

Beetling: The cloth is passed through a machine which is fitted with a number of very heavy wooden-headed hammers which rapidly beat it; this method fills up the surface of the cloth.

Calendering: The fabric is passed through a machine between two heavy rollers which are generally heated. In the form of calendering called Schreinerizing, the rollers are engraved with fine lines which transfer an impression to the cloth which gives a highly lustrous appearance to its surface.

Crease Resistance: The fabric is impregnated with urea formaldehyde by treating it with a liquid containing an acid catalyst and the urea and formaldehyde in the initial stages of condensation. It is then dried and after this subjected for two minutes to a very high temperature which hardens the resin *within* the fibre and renders it insoluble. The material is then washed to remove any surface resin which may adhere to it.

Embossing: The material is passed through two heavy rollers engraved with various designs which are transferred to the surface of the fabric.

Glazing: This is a highly lustrous finish used on the lightweight plain woven cotton furnishing cloth known as glazed chintz, also sometimes used on furnishing sateens. Such materials are produced in either plain self colours or in a wide range of printed designs. The glaze is given to the cloth by applying starch to it and then passing it through heavy calendering rollers; when the cloth is laundered the glaze is weakened, but it can be replaced by re-calendering. Another method is to lightly coat the material with wax before it is passed through the calenders; while this method gives a more permanent glaze which will withstand several launderings, the effect is not so good as that given by the first method, as it over-stiffens the cloth and detracts from its good draping qualities. An interesting and highly successful new method of glazing chintz consists in using a synthetic resin to form the glaze.

Mercerization: This process gives the cotton cloth a high degree of lustre which is quite permanent. In it the material is treated with caustic soda for a very short period (not more than a minute) and then washed while being kept stretched to its full width. If the cloth is allowed to shrink during washing, the process is ruined, for the fibres are thickened and no lustre is imparted. Yarn can also be mercerized before weaving.

Permanent stiffening: There are several methods by which a cotton cloth can be given permanent stiffening. These include impregnating the fabric with a solution of cellulose which is then precipitated within the fibres of the fabric by acids or other means. The precipitated cellulose assumes an insoluble form. Various other synthetic resins are also used to achieve the same object.

Raising and Shearing: This is a finish for flannellettes and other cloths of this type. The surface of the cloth is raised with special wire card clothing.

Singeing or Gassing: Loose or projecting fibres on the face of the cloth are singed off by passing it over hot plates.

Starching: Stiffening process.

Tentering: This is similar to the method for wool stentering already described.

RAYON

The first finishing processes for rayon, after bleaching or dyeing, are similar to those used for silk, but they are somewhat modified owing to the greater weakness of rayon fibres while in the wet state.

Anti-crease finish: This is the same process used for cotton which is described on page 150.

Calendering: Hot and cold calendering are much used, for this the fabric is passed between heavy bowls of compressed paper, brass, wood, or ebonite. Several types of finish can be produced in this way; moiré effects are made by calendering two fabrics at once, the effect being made by the irregular impression of the weft threads of one fabric on those of the other. Ciré finishes are made by calendering fabrics containing acetate rayon at such a high temperature as almost to melt the fabric, with a resultant very smooth and shiny surface resembling sealing wax.

Crepe Embossing: In this process advantage is taken of the rayon crepe's susceptibility to deformation under pressure. Various designs can be impressed on a rayon crepe by passing the cloth at high pressure between two rollers, the top roller being a heated steel cylinder on which the embossing design is engraved in relief. The bottom roller is resilient and made of compressed cotton material. The material is then de-sized and until this is done, and the material fully shrunk, it must be kept stretched to its full width, and quite free from creases. De-sizing is done by suspending the material in a de-sizing bath with a solution of soap. The material is left in this for one or two hours at a temperature of 110°–212°F., the exact temperature depending on the lustre and crepe effect desired. As a rule the higher the temperature the bolder the crepe effect, and, in the case of acetate rayon, the duller the lustre. The designs embossed can be small all-over and indefinite, or larger and more decorative. This finish is absolutely permanent, and the embossing takes place before dyeing. This is substantially the original silk mourning crape process mentioned in Section Three, on page 46.

De-sizing: This consists of treating with an emulsifier to which a solvent is added. If an acetate flat fabric is wanted with a matt surface, it can be delustred by the method used for delustring crepe cloths in the embossing process described above. Dyeing follows delustring.

Embossing: Fancy designs of all kinds can be made by embossing. This type of embossing is not permanent, and is only applied to flat rayons. It should never be called creping, but always embossing; true permanent embossed creping can only be applied to a *woven* crepe.

SPUN RAYON

De-sizing: This is done at width, the cloth being impregnated with malt or some other product which will liquify the starch which is the usual sizing agent. It is then scoured with soap.

Singeing: Most spun rayons are singed to remove the slight hairiness of the surface, unless they are intended for wool-like cloths.

SECTION THIRTEEN

LEADING BRITISH TEXTILE DESIGNERS

THIS LIST OF BRITISH textile designers includes designers both for furnishing and dress fabrics; it cannot, in the nature of things, pretend to be absolutely complete. New designers are constantly coming forward and many established artists in other spheres of the visual arts are more and more turning their attention to the possibilities of expression offered to them by textile design. But it does contain the names of the best known and established artists currently working for the industry at the date of publication. The names of two dead designers—Paul Nash and C. Lovat Fraser—are included, not only because the work they did for British textile design was important in itself, but also because of the very great influence which they have had on other workers in this field. Two other designers—Marion Dorn and E. McKnight Kauffer—are strictly speaking American citizens, but their work has for a very long period been intimately associated with British textiles and a very large number of their designs have appeared on some of the most successful cloths produced by British manufacturers, so that it would be invidious to omit their names from such a list as this. A few other foreign names appear but in such cases their owners have settled in this country and are working for British industry.

Bernard Adeny
Louise Aldred
Mea Angerer
Lida Ascher
Vera Astley
Edward Bawden

Keith Baynes
Cecil Beaton
Vanessa Bell
André Bicat
Reginald Birch
E. V. Borton
Mrs. Maurice Brown
Elsie Campion
Reco Capey
Rowland Catten
Charles Chapman-Mortimer
Frances Chapman-Mortimer
Mme. D. Charol
Josephine Cheesman
John Chirnside
Lucien Conradi
Barry Costin-Nian
Eva Crofts
Douglas Davidson
Phyllis Dimond
Joseph M. Doran
Marion Dorn
Bettina Ehrlich
Clifford Ellis
Rosemary Ellis
Joan Evans
John Farleigh
The late C. Lovat Fraser
Olga Gemes Forbat
Nina Gerhardi
Frank Gibson
Duncan Grant
Ronald Grierson
Jacqueline Groag
Kathleen Guthrie
Ashley Havinden
James Haward
Alec Hunter
Norah Hurford
Joy Jarvis
Joan P. Joseph
E. McKnight Kauffer
Margaret Lockwood
Mary Irene Loder
Diana Lowe
Marianne Mahler
Dorothy Martin
Kenneth Martin
Enid Marx
Elaine May
Minnie McLeish
John Meade
Pamela Meade
A. W. Mills-Porter
Kathleen Monk
Alastair Morton
Henry Moore
Riette Sturge Moore
The late Paul Nash
Ursula Neumann
Ben Nicholson
Michael O'Connell
Charles Paine
Lydia Pickering
Barbara Pile
E. Winning Read
A. F. Reare
Sir Francis Rose
Stephen Russ
Helen Sampson
Laurence Scarfe
Rex Silver
Margaret Simeon
Edward E. Simmonds
Amy Spencer
Josephine Staube
Graham Sutherland
John Tandy

Betty Tanner
Hans Tisdall
Felix Topolski
Meriel Tower
K. G. Treberne
Julian Trevelyan
Ursula Wakeman
Allan Walton
Karin Warming
Ellen Warrington
J. S. Wheelwright
Gerald Wilde
A. H. Williamson
George S. Willis
H. Woodman
Miriam Wornum

A SHORT GLOSSARY OF THE NAMES OF CLOTH IN MOST GENERAL USE

THIS SHORT GLOSSARY of cloth names makes no pretence of being an exhaustive one. The ramifications of cloth construction and the multitude of fibres used singly or in combinations would make a complete glossary impossible in a book of this size—it would need at least a volume to itself. The technical reader will probably find many omissions in this glossary, and I ask his indulgence for these. Weaving to-day has become so highly skilled and intricate an art that it is often quite impossible to describe a new cloth by any of the classic names; it may easily be made up of such a number of different weaves as to refuse to fall into any of the known categories and need a name of its own. I have avoided terms of this sort and also all those exotic and fashionable names which appear every season but which are, as a rule, too short-lived to be included in such a list as this.

I have tried to include in this glossary only those names of cloth or weaves which are in general use and among which I wandered in a bewildered way when I first began working with textiles; from my own experience I believe that the reader will find it convenient to have such an abridged glossary by him for quick reference—it can always be supplemented by reference to any standard text book, should a more detailed explanation be necessary.

The glossary includes names both of furnishing and of dress cloths.

ALPACA A dress and lining cloth which is almost always black. It is most generally made with a warp of fast-dyed cotton and a weft made of a mixture of the different natural-coloured alpaca yarns, the cloth being cross-dyed after weaving. The natural colours of alpaca are white, brown, grey, and black, but there is very little white alpaca yarn, so that pale-coloured alpaca cloths are seldom seen. The cloth is fine and lustrous in finish. The first alpacas produced in this country had a worsted warp and alpaca weft.

GLOSSARY

ANACOSTA Fine worsted dress fabric with an up-and-down twill-weave and soft handle.

ARMURE Dress cloth with an ondulé pattern which may run either in the direction of the warp, or of the weft. The embossed appearance of the ondulé figures is produced by interlacings of warp and weft. Usually made from worsted yarns, but also in fine wools or mixtures of cotton and rayon, mohair and cotton, etc. Cloths made from mixtures are usually cross-dyed.

BACKED CLOTHS Single cloths which have been given a backing of extra warp or weft threads. This is done either to obtain a different weave or colour on the back, or to give the cloth extra weight and strength.

BANDANNA Plain woven calico printed with a spot or florid design in white on bright red or dark coloured grounds. Chiefly used for handkerchiefs and scarves.

BARATHEA Very fine woollen dress cloth, chiefly used for men's evening dress suits and women's suits. The finest quality is made with a fine Botany wool weft and silk warp; lower qualities have a cotton warp and other kinds, mostly used for uniforms, have both warp and weft of fine cross-bred worsted.

BASKET WEAVE May be either a dress or furnishing cloth; the name completely describes its appearance.

BATISTE See CAMBRIC.

BEAVER Heavy, all-wool coating cloth with a fine face finish and a back of rougher appearance.

BEDFORD CORDS Clothing cloth mostly used for riding breeches. It has a plain-weave which gives the effect of rounded ribs which run warpwise. The best quality has both warp and weft of Botany worsted but it is also made in fancy coloured mixtures with warps either of white spun silk or coloured cotton and Botany worsted weft. Jacquard weaving is also sometimes used to produce Bedford cords with a figured pattern.

BENGALINE Dress cloth made from cotton, silk, worsted, or unions of different yarns. It has a warp rib which runs across the width of the cloth.

BOTANY TWILL Dress and suiting cloth, twill-woven with a Botany wool warp and weft.

BOUCLÉ Name given to any kind of dress cloth which is woven with bouclé yarn. This yarn is a special fancy type, as a rule made of a union of fibres, the various threads used in it each having a special twist which, when combined together, give the completed yarn its character.

BOX CLOTH Very heavy all-wool clothing cloth with a fine face finish.

BROADCLOTH Fine all-wool clothing cloth with a fine face finish.

BROCADE Made both as a dress and as a furnishing cloth. Historically, the name is applied to a finely woven fabric to which one or more extra colours have been added by means of shuttles used where the extra colour appears on the face of the material. The name is used to-day to describe any finely woven multi-coloured fabric which resembles the original material. Usually made of silk or rayon and sometimes has additional metal threads.

BROCATELLE Furnishing cloth. The name was originally used to describe a cloth with a raised design in the warp with a plain weft background. Used to-day to describe any cloth with a raised woven design on a plain background.

BUCKRAM A coarse, plain-woven linen cloth used for stiffening in the tailoring and millinery trades. It is very heavily sized, after weaving, to give it the required stiffness for the purposes for which it is used.

BUTCHER'S LINEN As its name implies, this is a linen cloth primarily made for use as butchers' aprons. It is a very strong and heavy plain weave with rather a stiff handle, and is usually woven in dark blue and white stripe effects. Also has certain limited dress uses.

BUNTING Thin-textured plain-woven cloth used for flags and outdoor decorations. Made from mohair, worsted, or cotton yarns.

CALICO Plain-weave cotton cloth.

CAMBRIC or BATISTE Very fine plain-woven cloth usually made from linen or cotton and chiefly used for handkerchiefs, *lingerie*, and children's clothes. The name comes from the French town of Cambrai, where it was first made.

CANTON Plain woven light-weight cloth, usually made from a union of cotton and wool, or all-wool.

CANVAS Plain open weave cloth made with hard twisted yarns.

CASEMENT Plain-weave cotton furnishing material. Comes both in plain self colours, and with printed designs on tinted or natural coloured grounds.

CASHMERE Plain-weave dress cloth entirely made from cashmere wool obtained from the Tibetan goat. The name is also sometimes used to describe other fine quality dress cloths with a silk or cotton warp and weft of fine Botany wool.

CELLULAR Cloths with an open mesh appearance produced by gauze weave. Used mostly for underwear and sports shirts.

CHALLIS Lightweight dress cloth made from a union of silk and wool.

CHENILLE Pile furnishing cloth. The weft is either specially twisted on a chenille machine before weaving, or woven and cut and then woven into the warp to make the pile.

CHEVIOT CLOTH Clothing cloth originally made from Cheviot wool. The name is used to-day to describe cloths made from cross-bred worsted yarns.

CHIFFON Extremely light-weight and transparent silk tissue. This is the softest and thinnest of all woven materials.

CHINÉ Any plain-woven patterned material with a blurred design made by printing the warp before weaving. Warp printed chiné effects are used for silk and rayon dress materials, ribbons and for certain types of cotton furnishing cloths.

CHINTZ Calico furnishing cloth which has been given a highly glazed and stiff finish. May be either plain self colours or with printed designs. There are two types of finish for this cloth: fully glazed, in which the finish is made by the application both of starch and pressure, and half-glazed, where pressure alone is used. Stiff chintzes are also sometimes made with a finish made by the application of wax and pressure, but the surface here is inclined to crack with wear and is not as satisfactory as the starch and pressure finish.

COMBINATION TWILLS Two or more simple weaves combined to give the cloth a fancy twill effect. The twills can be either warp or weft-wise.

CORDUROY Pile cloth which has its floats bound continuously into the warp, in the direction of the warp. After weaving, these lines are cut, which produces a dense pile cord. Made either in all cotton or in cotton and wool union.

CORSET CLOTH Heavy and strong cloth which may be either plain woven or with a Jacquard figure. It has both a cotton warp and weft but rayon threads are often introduced to heighten the effect of a figured pattern.

COTTAGE WEAVE See FOLK WEAVE.

COUTIL Very heavy and strong cotton cloth used for corset linings. Usually made with a herringbone type of weave.

COVERT COATINGS Made from solid mixture and twist yarns, either in all-wool or with a warp of cotton and worsted and a Botany wool weft. Produced in both light and medium weights.

CRAMMED STRIPE Material with woven stripes made by "cramming" more threads into some sections of the stripes than in others.

CRASH Coarse and heavy linen cloth used for towelling.

CRAPE Silk cloth in gauze weave, sometimes stiffened with shellac, which is given its characteristic figure and appearance by embossing after weaving. This embossing is done by passing the crape over heated revolving cylinders on the surface of which the desired pattern has been engraved. Crape is almost entirely used as a mourning material and therefore is almost invariably black, though both white and coloured crapes are sometimes made.

CREPE Dress cloths woven with irregularly distributed interlacings which give the surface of the cloth a somewhat broken character. Produced in a large number of variations of weave and made of silk, rayon, wool, or cotton, or in mixtures of these different yarns.

CRÊPE DE CHINE Fine dress cloth made with a hard twist weft in silk or rayon, or rayon and cotton mixture. Has a smooth and lustrous finish and is used for dresses, blouses, *lingerie*, and children's clothes.

CRÊPE GEORGETTE See GEORGETTE.

CRÊPE SUZETTE Very lightweight and transparent dress fabric, which is given a pronounced and permanent crape-like finish. Used for blouses and *lingerie*.

CREPONS or CRIMPS Dress cloths which are made from silk, rayon, or cotton. They have a surface pattern of raised or "blistered" stripes which may be produced in several ways: by a combination of weaves, by combinations of yarn, by combinations of both weaves and yarns, or by the final finishing process. Cotton crepons are usually given their characteristic stripe by the finishing process which is of two kinds: in the first, the stripes are printed on the woven cloth with a suitable shrinking agent, and the cloth then put through the usual finishing process. In the second method, the stripes are printed with a resin which resists shrinking agents, and the cloth is then immersed in a shrinking bath. In both these finishing processes "slack" areas are created which give the crimped stripe effect.

CRETONNE Strong plain-woven furnishing cloth. It is produced dyed in plain colours or printed by various processes, or also sometimes made with a printed warp which gives a chiné or shadow pattern to the finished cloth.

CRIMPS See CREPONS.

DAMASK A figured fabric named after the city of Damascus. It has a characteristic appearance given by the contrast between the figured weft weave and the warp weave of the ground. It is made either in silk, rayon, cotton, or linen; the silk and rayon damasks are mostly used as furnishing materials and the linen damasks for table cloths and napkins and best grade hand towelling. Rayon damask, and rayon and cotton mixture damasks are also used for table cloths and napkins. In silk and rayon damask, metal threads are sometimes introduced to heighten the figure; in rayon furnishing damasks this heightened effect in the figure is more usually obtained by the use of a rayon thread with a higher degree of lustre than those used elsewhere in the cloth.

DAMASSIN A word sometimes used to describe a damask in which gold, silver, or coloured metal threads have been used in the weft.

DELAINE Lightweight all-wool plain-weave dress cloth. Produced in plain self colours or with a printed surface.

DENIM Very strong and heavy plain cotton fabric used for boiler suits, overalls, and similar garments.

DIAPER Term used to describe either the pattern of a certain weave, or the cloth woven in it, which is usually a linen. The pattern is a small diamond-shaped twill.

DIMITY Cotton fabric of light quality with stripe or check design woven in thick cord yarn. Sometimes printed.

DOESKIN Fine quality all-merino wool cloth.

DOMESTIC Cotton export cloth with a plain weave.

DOUBLE CLOTHS Two or more cloths which are woven on one loom at the same time; they are held together during weaving by binding threads, or sometimes a special binding warp is used. This method produces cloths which can either be alike on both sides, or have a different structure or design on either face.

DOUBLE PLAIN A double cloth with two different plain-weaves on either side, which interplay with each other to make the design which binds the two cloths together.

DRILL Cotton or linen sheeting material with a twill weave.

DRUGGET A coarse, heavy cloth used as an overlay cover to protect carpets. It is generally made with a heavy linen warp and a wool weft, but it is also produced both in jute and in cotton.

DUCK Strong, plain-weave cotton cloth which comes in various qualities.

DUNGAREE A strong drill which has both a coloured warp and weft.

DUVETYN Wool dress cloth with a close weave and fine raised surface which gives it a suede-like appearance.

FAILLE Plain-weave silk dress fabric woven from silk net yarns. Has more warp threads than weft threads to the inch, which gives it a warp rib resembling poplin.

FELT Material made from successive layers of carded wool fibres mixed with cotton and pressed together under heat by rollers. Soap, water, and acids are also used to help the amalgamation of the fibres. True felt is never woven. Felt is produced in various heavy qualities for hat-making, and in lighter weights for upholstery and curtains.

FIGURED CREPON or FIGURED CRIMPS Dress cloth similar to ordinary crepons but with a figured crimped pattern instead of a stripe.

FLANNEL Twill-woven, all-wool cloth with a soft and supple finish. Used for shirts and blouses, pyjamas, underwear, and children's clothes.

FLANNELETTE Cotton fabric with the pile raised on both sides to give the appearance of flannel; used as an economical substitute for the latter cloth. Produced in plain colours and with surface prints.

FOLK WEAVE or COTTAGE, VILLAGE, or PEASANT WEAVE. The term used to describe certain loosely woven furnishing materials made of coarse yarns and of countrified appearance.

FOULARD Fine silk dress material, either plain or twill woven, which has an exceptionally full and soft handle. Used for blouses, dresses, scarves, and ties, and is usually decorated with printing.

FRENCH CASHMERE Dress cloth made with a Botany wool warp and cashmere weft.

FRIEZE Coarse wool fabric with a rough tweedy appearance. Mill finished to give it a fibrous texture.

FURNISHING TWEED Furnishing cloth similar in type to dress tweeds but woven from heavier and coarser yarns. Mostly used for upholstery but can also be used as a curtaining material.

GABARDINE Clothing cloth principally used for overcoats and raincoats; it has an upright twill weave. This name is also used to describe lighter weight ladies' dress cloths of similar construction.

GALATEA Serviceable cotton warp twill cloth mainly used for nurses' dresses and children's suits.

GAUZE or LENO Very fine and transparent open-textured cloth, which is woven with some of the weft threads pulled out from the straight and bound to the warp threads on either side of them. Many variations of pattern are possible with this weave.

GEORGETTE or CRÊPE GEORGETTE Very lightweight and transparent dress cloth made with a hard twist yarn; in its construction yarns with a right and left hand twist are used alternately. Made of silk or rayon and is also produced with lightweight wool yarns. The silk or rayon qualities are used for dresses, blouses, and *lingerie*, the wool qualities for dresses and light summer coats.

GINGHAM Plain-weave cotton cloth which is produced in a wide variety of woven single and multi-colour checks, both large and small. Used for summer dresses, blouses, children's clothes, for simple kitchen and bathroom curtains, and for country style tablecloths and napkins.

GLACÉ Term used to describe any cloth, whether plain or figured, which has a highly lustrous surface finish and somewhat crisp handle.

GLASS TOWELLING Narrow width, plain-woven and very smoothly finished linen cloth made of twisted yarns, which is used for wiping glass and crockery. It is characterized by a highly absorbent quality. Lower qualities are also made in a union of linen and cotton. It is usually woven with a design of single coloured stripes at regular intervals, the finished length of cloth being cut between these to make the towels, which thus have coloured stripe ends. It is also produced with all-over single or multi-colour woven open check designs. Some modern cloths of this kind are also frequently embellished with printed designs.

GLEN URQUHART CHECK The best known of the traditional Scottish "Glen" checks, which is very popular both in woollen and worsted clothing cloths.

GRENADINE Semi-transparent dress cloth often made in check designs with transparent portions in gauze weave. Made either in silk, rayon, worsted, cotton or unions of these yarns.

GROS-GRAIN Fine rib dress cloth, made either of silk or rayon.

GUN CLUB CHECK Another of the traditional Scottish "Glen" checks. It is a small three-colour woven check, usually used for woollen clothing materials.

HABIT CLOTH Fine quality heavy woollen cloth made specially for ladies' riding habits. Produced in black and other dark shades.

HAIR CLOTH Tailor's stiffening cloth made with a cotton warp and a weft of coarse hair.

HARVARD SHIRTING Colour-woven twill shirting material.

HERRINGBONE WEAVE In this some threads are twisted first to the right and then to the left. Many variants can be made by reversing the direction of the twill.

HESSIAN Plain-woven jute fabric.

HOLLAND An unbleached, plain-woven cloth used for roller window blinds; usually finished with an oil and starch glaze. The name is also sometimes used to describe a plain woven, unbleached linen dress cloth. Window-blind Holland is made in plain dark shades, such as black, dark blue, and dark green, as well as in natural biscuit colour.

HOMESPUN Any cloth made in the weaver's own home and not in a factory; generally also made with hand-spun wool.

HONEYCOMB WEAVE This name exactly describes the appearance of a cloth woven in it; the design is produced by differences of construction in its various parts; many variations are possible. This weave is used for woollen dress cloths and to make heavy standard cotton materials for bed-spreads.

HOPSACK Wool dress cloth with an enlarged plain-weave.

HUCKABACK Cotton towelling cloth with a rough surface and plain-weave ground.

ITALIAN CLOTH Lustrous surfaced lining cloth; the best qualities are made with a cotton warp and a Botany wool weft, lower grades are made in all cotton. The lustrous finish is given by a special hot-press process.

JEANS Heavy cotton twill cloth used for overalls, boiler suits and workmen's trousers. Usually blue.

KASHA Dress cloth made of cashmere wool blended with merino wool.

KERSEY Twill-weave all-wool cloth.

LAWN Fine plain-weave linen cloth used for handkerchiefs, blouses, and *lingerie*.

LENO See GAUZE.

MADRAS MUSLIN Furnishing material used for curtains. It has opaque figures on a plain-weave transparent ground, the floats used in constructing the figure, being cut away after weaving.

MAROCAIN Dress cloth which is made of silk, rayon, wool, or cotton. It has a poplin or repp type of weave, but the appearance of the cloth is different to that of an ordinary poplin or repp, owing to a spiral weft being used. This cloth is also often made with a knop or slub yarn which still further enhances its characteristic grained appearance.

MARQUISETTE An open-textured cloth which somewhat resembles a voile but with a more open mesh. Generally made of silk or rayon and sometimes of fine cotton.

MATELASSÉ Any material with a raised figure produced by the insertion of wadding.

MELTON All-wool or wool and cotton cloth, milled and raised. The nap is cut to the required density and completely hides the weave.

MERINO Fine quality twilled dress cloth made from the best merino wool. The name is also used to describe a fine underwear material made from a mixture of wool and cotton.

MILLED CLOTH Any woollen cloth which has been given a milled finish resulting in a very close surface which makes the character of the weave indistinguishable. The process consists of the application of friction and pressure to the cloth while it is in a wet and soapy condition.

MOIRÉ Made in both dress cloth and furnishing qualities. It has a very closely woven rib and a highly lustrous surface finish which gives a "watered" figure. This is produced by distorting the ribs under pressure. Made both in silk and rayon.

MOQUETTE Heavy upholstery velvet usually woven as a double cloth, the two grounds with their connecting threads being cut apart after weaving. Generally has a wool or ramie pile and a cotton ground. Is produced in plain, cut, uncut or frieze qualities, as well as also being made with a Jacquard woven figure.

MUSLIN Lightweight plain-woven cotton cloth; available in plain white or in dyed colours; it is also sometimes printed.

NINON Fine and closely woven plain-weave semi-transparent dress cloth made either in silk or rayon. In plain self-colours or printed. Used for dresses, blouses, and *lingerie*.

NUN'S VEILING Very lightweight worsted dress fabric with a soft handle. Used for blouses, dresses, nightdresses, children's clothes, etc.

OATMEAL CLOTH Dress cloth with an uneven surface appearance produced by the use of uneven warp and weft yarns or by irregular interlacing of the weave.

ORGANDIE Thin, transparent plain-woven dress cloth which is given a special, crisp permanent finish. Produced in white and a large range of plain colours, and also in printed and embroidered qualities. Fancy figured thin cotton cloths are also given the special organdie finish and described by this name; thin cotton cloths in fancy gauze weave which have been given this finish are also called organdie.

ORGANZA Lightweight, transparent dress cloth made either of silk or rayon which has been given the crisp, organdie finish.

OTTOMAN Dress material in either silk or rayon with a broken rib face and plain-weave back. It is produced in various sizes of rib.

OXFORD SHIRTING Plain or fancy woven striped shirting cloth.

PALM BEACH CLOTH Generic term for various kinds of very lightweight plain-woven cotton or worsted cloths used for tropical suits.

PANNE VELVET Flat piled silk velvet.

PERCALE Fine, plain-weave cotton furnishing cloth which is usually printed and given a glazed finish.

PILE FABRICS Any fabric which has a plain ground with an extra warp or weft which projects to give the surface a fibrous nap. This nap may be in the shape of loops, which are left as they are as in the case of imitation astrakhan, or cut after weaving to form a close surface as in the case of velvet or velveteen. The pile may be either a weft pile, in which case the extra material is floated to the surface, or a warp pile which is made by looping the extra warp threads over wires which are removed after weaving. Warp piles may also be made as a double cloth (see MOQUETTE), two ground textures being woven at the same time leaving a space between them across which the warp threads are passed from one to the other. These connecting threads are cut after weaving.

PILOT CLOTH Heavy wool clothing cloth with a raised and milled surface finish. Produced in many different qualities, the best quality being chiefly used for overcoats and the medium type for uniforms.

PIQUÉ or WELTS All-cotton dress cloth which resembles a Bedford cord. The structure is made of two warps and two wefts, one of the latter being thicker than the other and used for wadding. The cords run vertically on the fabric. Used for summer dresses, beach wear, children's clothes, facings and other dress trimmings. Fancy figured piques are also made which are much used for men's evening dress waistcoats.

PLAIN-WEAVE or TABBY WEAVE The simplest form of interlacing in which each warp thread interlaces alternatively over and under each weft thread.

PLUSH Warp pile fabric usually made with a mohair pile warp on a cotton ground. Made in plain cut or uncut piles and also with figured designs.

PONGEE Plain woven cloth with natural coloured fine silk warp and weft.

POPLIN This material which was first woven in Avignon, was originally called "Papeline" from its being made in Papal territory. The name became corrupted to Poplin; it is a plain weave with a thick weft which gives the material the effect of having a warp rib structure. Made in silk, cotton, wool, and rayon, both in dress and furnishing qualities.

SATEEN Light-weight cotton cloth with a satin weave and lustrous surface finish. Used for linings, both in the dress and furnishing trades. Good quality sateens are also often printed for use as an economical curtain material.

SATIN Dress or furnishing material with a very smooth and lustrous finish, usually woven with the warp forming the face. The weave is very close and in the finished cloth its structure is imperceptible. Originally made of silk, it is now produced also in rayon. Cheaper qualities are made with a silk or rayon surface and a cotton back.

SATIN BEAUTÉ Crepe-backed satin, either silk or rayon.

SATIN GRENADINE Dull-finished satin with warp of net silk and weft of spun silk.

SAXONY CLOTHS Best quality all-wool dress, coat and suiting cloths. They are of various types, including simple and fancy weaves, and are given several different finishes such as milled, raised and cut pile, rough fibrous pile, or curly fibrous pile.

SCHAPPE SILK Fabric made from spun silk which has not been fully degummed.

SEERSUCKER Name often used to describe cotton crepon stripe or check materials, usually multi-coloured.

SERGE Twill-weave worsted dress, coat, and suiting cloth.

SHADOW STRIPES and CHECKS An optical illusion is used to give these their shadowy effect. This is created by using yarns of two different twists in the warp or the weft or in both, one yarn having a right-hand twist and the other a left-hand one. This causes the light to be reflected from opposite directions from the finished cloth, which gives the design an illusive, shadowy appearance.

SHADOW TISSUE Furnishing cloth with the design printed on the warp before weaving.

SHANTUNG or TUSSORE Plain-woven silk cloth with a rough surface due to the use of knop yarns. Oriental in origin, it was made in natural coloured silk. It is produced to-day in a wide range of colourings. Used for dresses, blouses, scarves, etc.

SHEETING Cotton or linen cloths in varying weights, either plain or twill weave, which are used for bed linens.

SHOT FABRICS Made with a dyed warp and weft of a different colour.

SLUB REPP Furnishing repp made with a weft of slub yarn.

SPONGE CLOTH Coarse, plain-woven cotton cloth made with both warp and weft of fancy twisted yarns. Produced in plain colours and in stripes and checks.

TABBY See WATERED FABRICS.

TABBY WEAVE See PLAIN-WEAVE.

TAFFETA Plain-weave self-coloured or shot colour effect fabric made in both dress and furnishing qualities. It is made in silk, rayon, or worsted, or in mixtures of silk and cotton, and rayon and cotton. Silk and rayon taffetas and those made of a union of either of these fibres and cotton are characterized by a highly lustrous surface and stiff, crisp handle. The silk, rayon, and union taffetas are also often made with colour woven stripe and check designs. Worsted taffetas are made in plain colours and in checks and stripes and are extensively used as men's shirting materials.

TAPESTRY A figure-woven furnishing cloth, which may be either all wool or partly wool, or woven with other coarse yarns. Its design is generally in imitation of wool cross stitch embroidery, though other types of design are also used. The name is also used to describe any furnishing fabric in which the colours in the design are entirely or partly to be found in the warp.

TISSUE A finely woven cloth in several colours; the design is formed by the weft threads.

TULLE Very fine, lightweight, transparent fabric with a somewhat stiff and crisp finish; originally made of fine cotton, it takes its name from the French town of Tulle where it was first made. It is made to-day in silk, rayon, or cotton, and used for millinery and dress trimmings.

TWEED Dress, coat, and suiting cloth of Cheviot wool which is woven in a two and two twill. The name came from a misunderstanding—cloths of this type were sent to a London dealer labelled "Tweel" (the Scottish term for twills) and this was thought by him to be a mistake for the name of the river Tweed, on which the village from which the goods came was situated. Since then the name Tweed has been universally adopted for these cloths.

TWILL-WEAVE Interlacing pattern running diagonally across the cloth, instead of, as in non-twill weaves, following the direction of either warp or weft. Cloths made with twill weave are heavier and more compact than those of plain weave. The twill may be plain, zig-zag, broken, corkscrew or figured combinations of these forms.

UMBRELLA CLOTH Fine plain-weave cloth for covering umbrellas, made of silk, rayon, or cotton or in mixtures of these yarns.

UNION CLOTH A fabric in which the warp and weft are of yarns of different fibre.

UTRECHT VELVET Heavy upholstering velvet made of mohair or of cotton and mohair.

VELOURS Wool pile fabric with a very dense, close, erect pile; produced in both dress and furnishing qualities.

VELVET Very fine and close upright pile fabric woven over wires or face to face; the pile is made by cutting the warp threads. May be either plain or with a figured pattern and is made in both dress and furnishing qualities. Originally the word was used to describe a material only made in silk; to-day it is used to describe any material made by this method.

VELVETEEN Dress and furnishing fabric made in imitation of velvet. It has a close, upright pile made by cutting the weft threads after weaving.

VILLAGE WEAVE See FOLK WEAVE.

VOILE Transparent lightweight fabric made with hard twisted yarns. Made chiefly as a dress fabric, though there are also some furnishing voiles. Produced in silk, rayon, cotton, and worsted. Made in a range of plain colours and also with printed designs, both in the dress and furnishing qualities.

WATERED FABRICS Materials in which a water-wave pattern has been produced by a finishing process to imitate moiré. The materials thus treated are of plain-weave and made either of rayon, silk, or cotton, and are produced in both dress and furnishing qualities.

WELTS See PIQUÉS.

WINCEYETTE Fine single warp flannelette.

WINSEY Cotton flannelette made of super quality yarns. The best qualities have an admixture of wool.

ZEPHYR Lightweight plain-weave cloths made either of silk, wool, or cotton. Usually made in woven checks or stripes in pastel colourings. Better qualities are made with a worsted warp and a weft of spun silk.

ZEPHYR GINGHAM The finest quality gingham.

ZIBELINE Dress and coating cloth made of a union of merino wool and fine camel's hair. It has a raised surface finish. Lower qualities are made with a union of wool and cotton and mohair noils. (Noils are a by-product of the process of wool combing.)

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ILLUSTRATIONS

in monochrome

Plates 1–20. Dress materials.

Plates 21–24. Trade goods.

Plates 25–48. Furnishing materials.

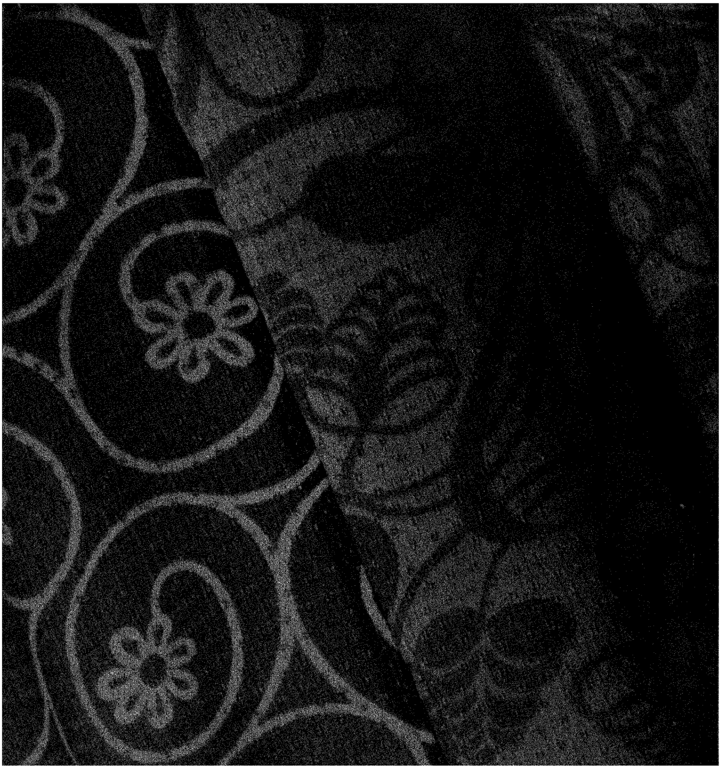


PLATE 1

Above: Two examples of printed "Toolina," 100 per cent spun viscose dress fabric, with a leno weave and Tebilized crease-resistant finish. The material on the left has a white design on pale lime-green ground; on the right, a saxe-blue design on soft cyclamen ground. Note how pleasantly the texture of the leno weave brings up the bold shapes of the overprint.

Tootal, Broadhurst, Lee Company Limited

Right: Two examples of "Celarove" spun rayon dress material, with fine hopsack weave. Printed in white on various coloured grounds.

British Celanese Limited.

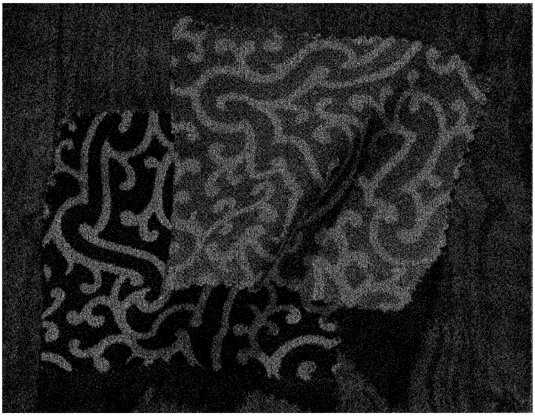
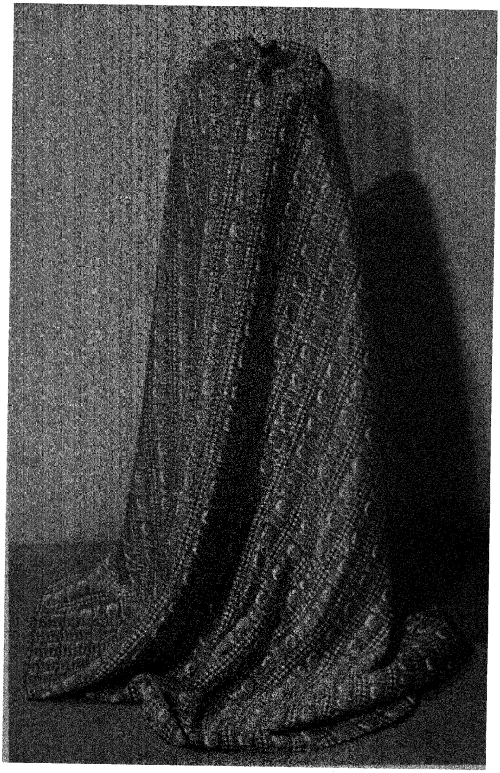
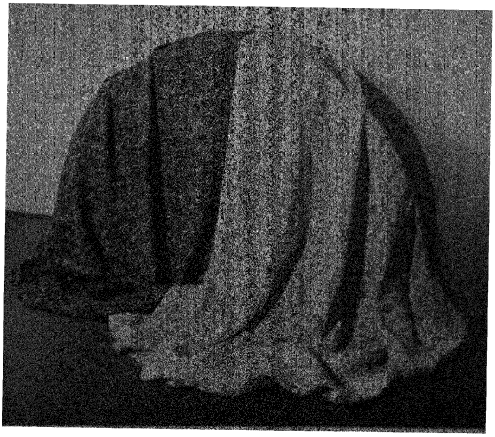


PLATE 2

Right: Rayon *crêpe de Chine* printed in close all-over design, reminiscent of cabochon jewels, in turquoise blue and white.



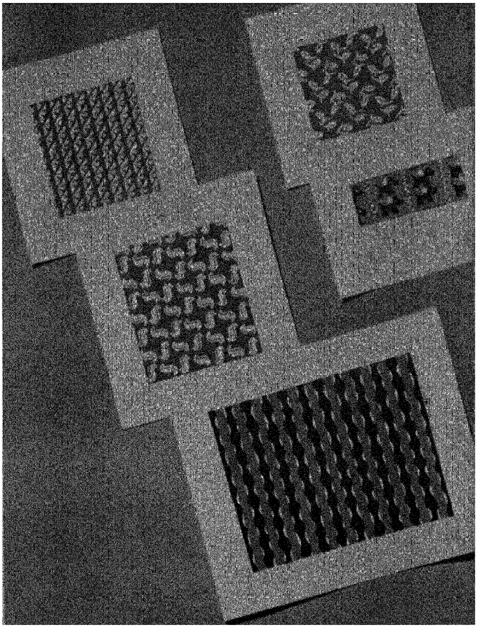


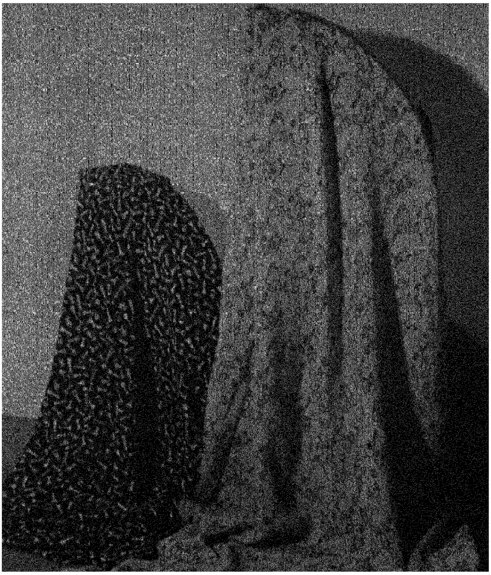
Left: On the left is a rayon *crêpe de Chine* printed in two shades of dark grey on white, with design resembling the texture of woven tweed. On the right is a rayon *crêpe de Chine* with silhouette design of Victory Day figures; single colour print on various coloured grounds.

Grafton Dress Fabrics Ltd.

PLATE 3

Right: Group of typical modern small prints on rayon *crêpe de Chine* or marocain, for town summer dresses or blouses. Some are printed in white on various dark grounds, others are two-colour prints on pastel grounds.





Left: On the left is a staggered design of old English drinking glasses, in white on various dark coloured grounds. On the right is a silhouette design printed in single colour on a white ground.

Grafton Dress Fabrics Ltd.

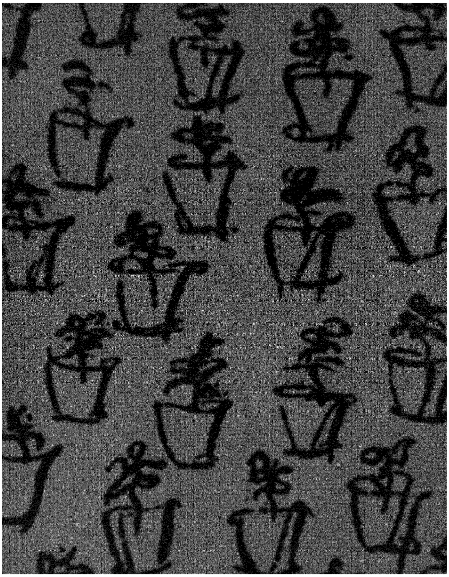
PLATE 4

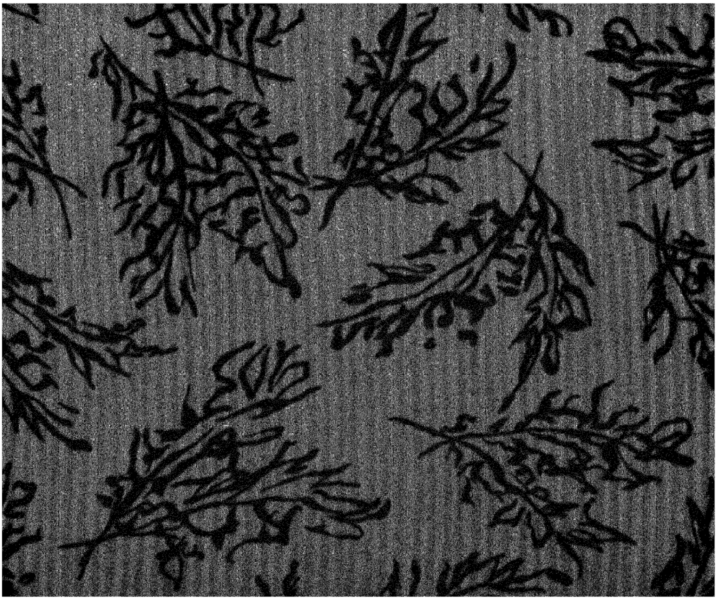
Right: Spun rayon dress material with a coarse hop-sack weave, screen printed, with a single colour design.

Below: Screen printed pure silk and rayon crêpe dress material.

Both designed by Lida Ascher.

Ascher (London) Limited.





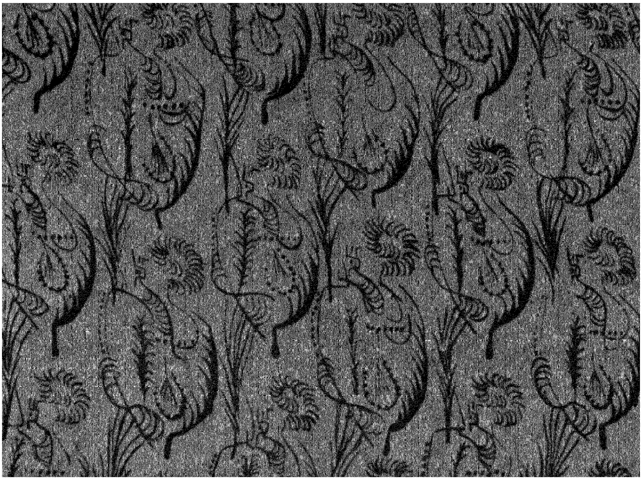
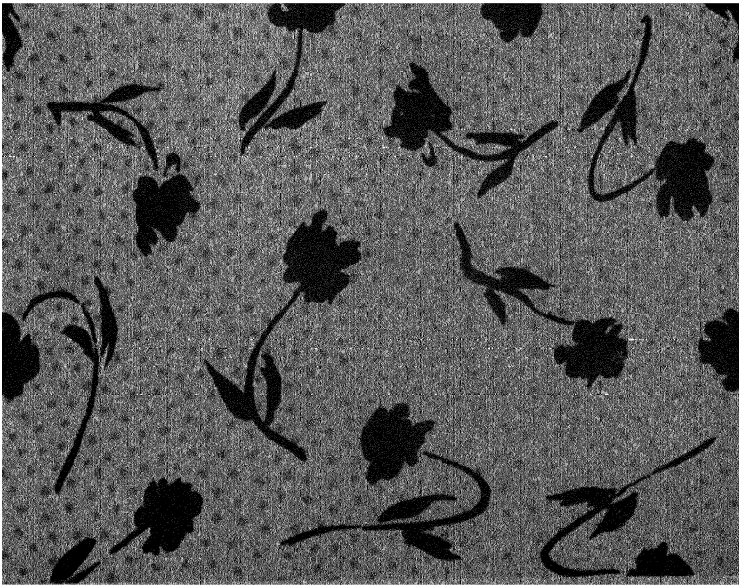


PLATE 5

Above: Screen printed pure silk dress material. Designed by Henry Moore.

Below: Screen printed pure silk and rayon crêpe dress material. Designed by Lida Ascher.

Ascher (London) Limited.



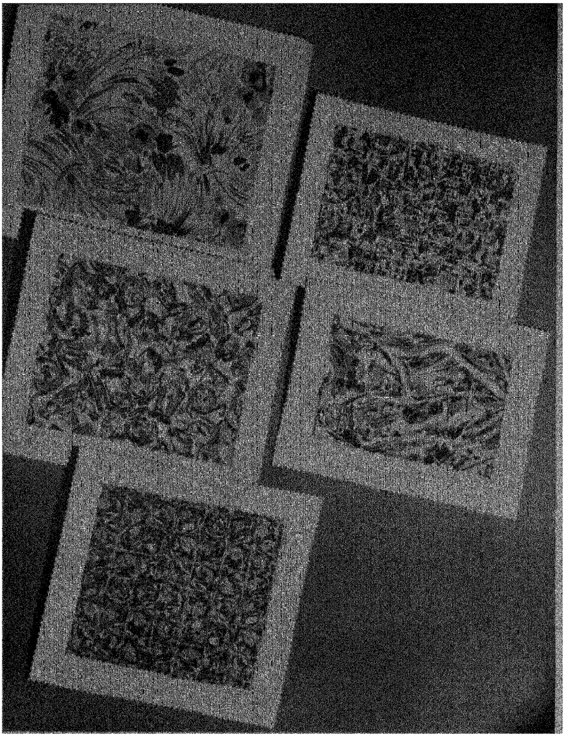
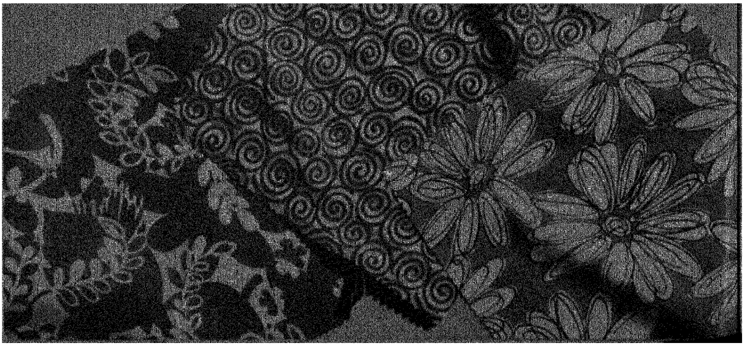


PLATE 6

[illegible] of small, brightly coloured designs, ranging from conventionalized corn and poppies to romanticized tea and coffee urns and pictorial urban and rural scenes; all on lightweight cotton dress cloth.

Edmund Potter & Company Limited.

Below: 100 per cent spun viscose plain weave with slight slub, and treated with "Lystav" crease-resistant finish; suitable for lightweight summer dresses. *Tootal, Broadhurst, Lee Company Limited.*



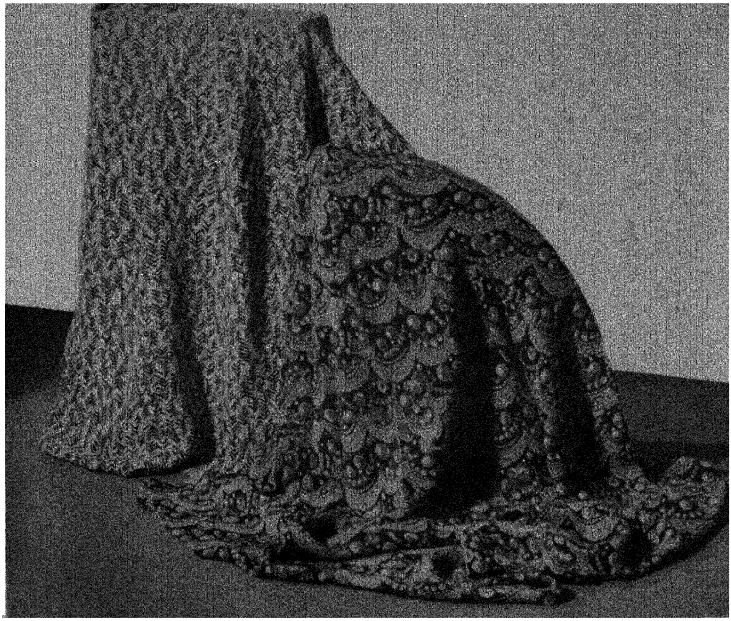
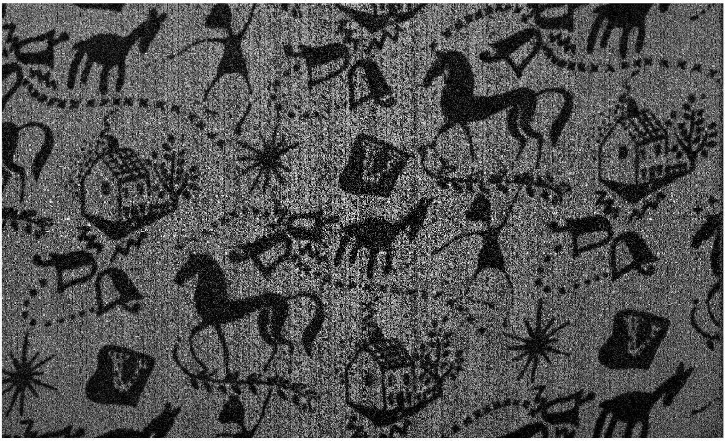


PLATE 7

Above: Two rayon *crêpe de Chine* dress fabrics. On the left a print simulation of tweed weave, but developed in single colour print on various contrasting light coloured grounds; on the right, a romantic design of lace scrolls and pearl necklaces, in dark greys and yellow on dark tobacco brown ground. ***Grafton Dress Fabrics Ltd.***

Below: Screen printed rayon marocain with single colour Victory design in black on beige ground; 100 per cent rayon. Designed by John Farleigh for ***Marshall Fabrics Ltd.***, and modelled by Molyneux.



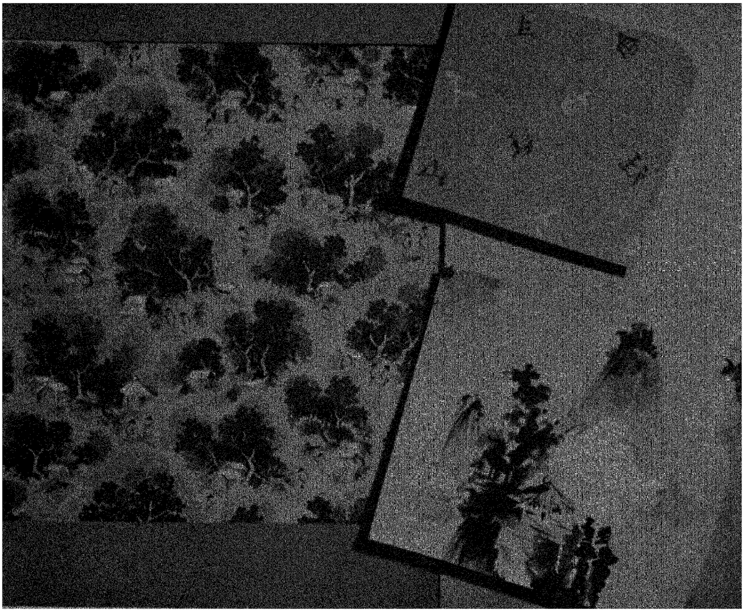
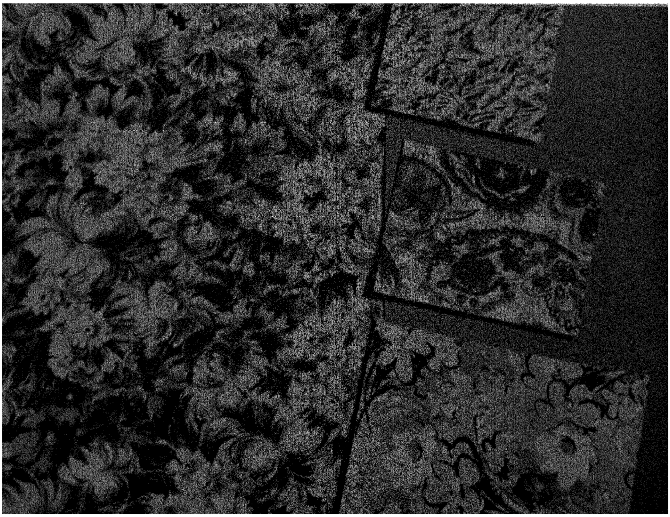


PLATE 8

Above: Oriental themes for printed rayon *crêpe de Chine* and marocain.

Below: Typical English treatments of the perennial floral theme for rayon *crêpe de Chine* and marocain.

Grafton Dress Fabrics Ltd.



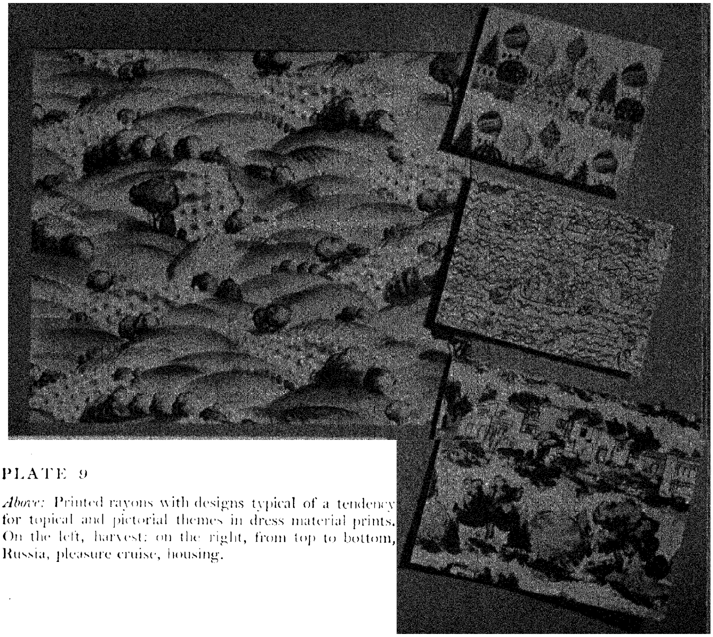
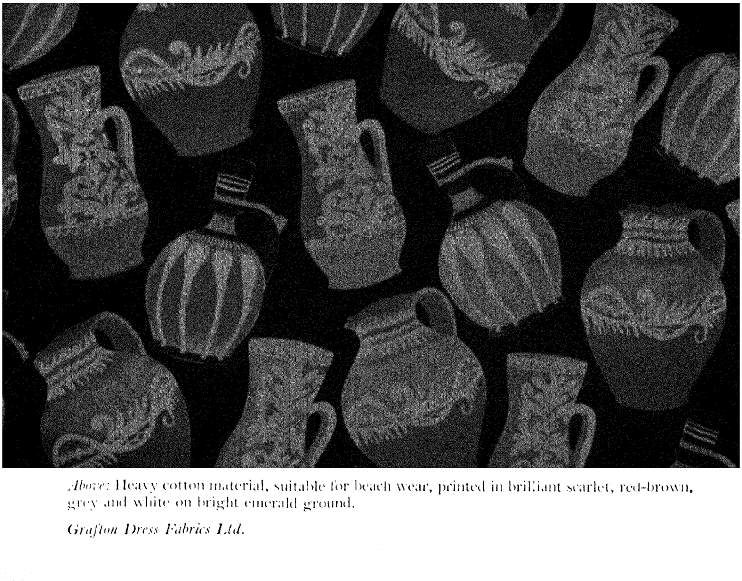


PLATE 9

Above: Printed rayons with designs typical of a tendency for topical and pictorial themes in dress material prints. On the left, harvest; on the right, from top to bottom, Russia, pleasure cruise, housing.



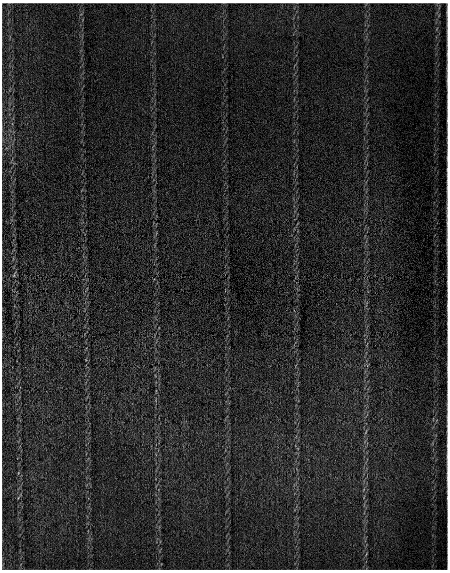
Above: Heavy cotton material, suitable for beach wear, printed in brilliant scarlet, red-brown, grey and white on bright emerald ground.

Grafton Dress Fabrics Ltd.

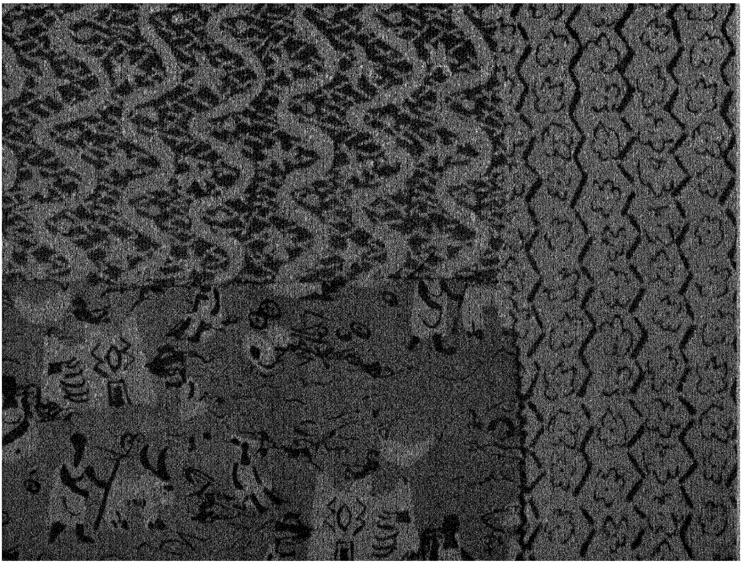
PLATE 10

Right: Long cut-staple rayon, linen weave; design consists of woven white cable stripe on various coloured pastel grounds; a Moygashel fabric.

Stevenson & Son Ltd.



Below: Three dress fabrics by *Ascher (London) Limited.* On the right, and left above, hand blocked prints on spun rayon, designed in the Ascher studio; on the left below, African scene, also on spun rayon, but screen printed, and designed by Julian Trevelyan.



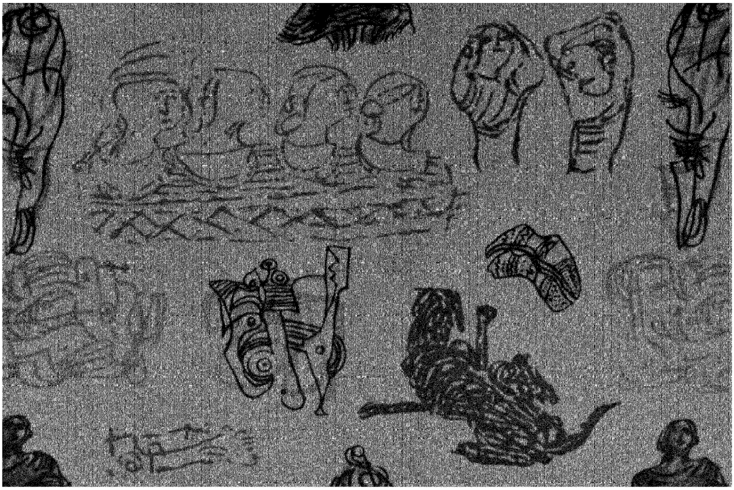


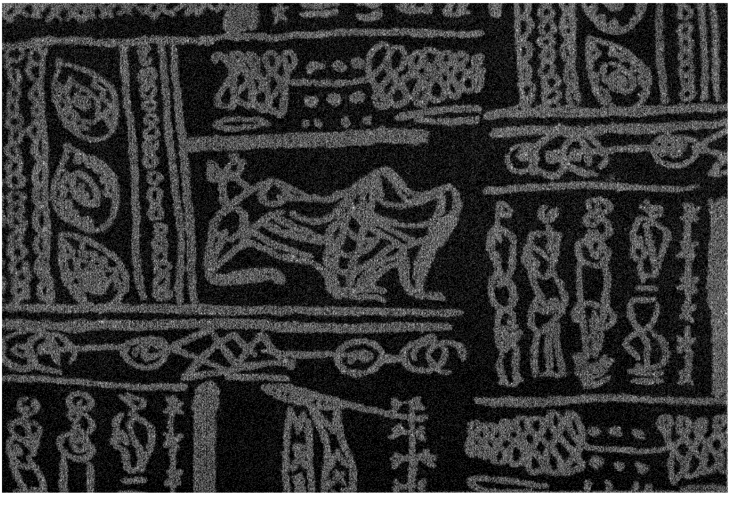
PLATE 11

Above: Screen printed pure silk and spun rayon dress material.

Below: Spun rayon dress fabric, screen printed in single colour on various coloured grounds.

Both designed by Henry Moore.

Ascher (London) Limited.



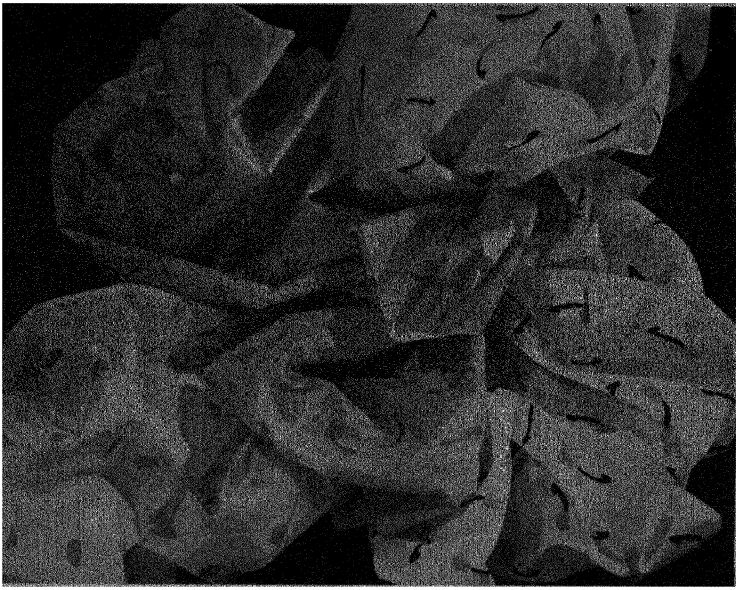


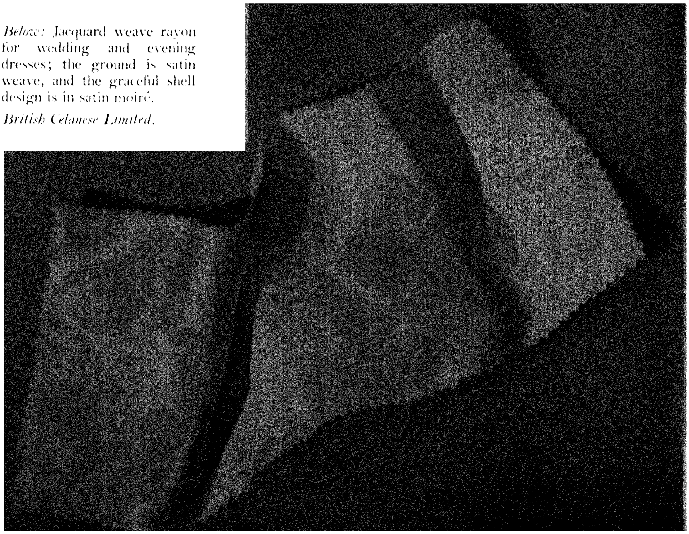
PLATE 12

Above: Fine woven nylon of taffeta type, with conventional floral design printed in two colours.

Ascher (London) Limited.

Below: Jacquard weave rayon for wedding and evening dresses; the ground is satin weave, and the graceful shell design is in satin moiré.

British Celanese Limited.



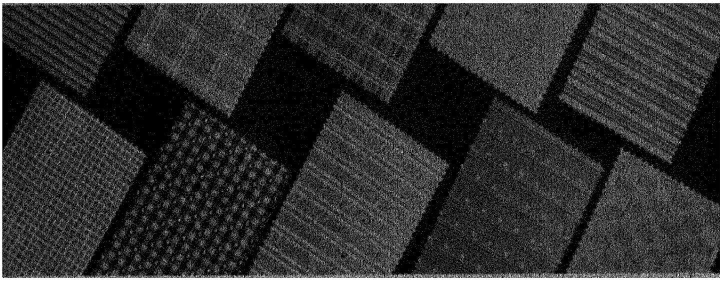
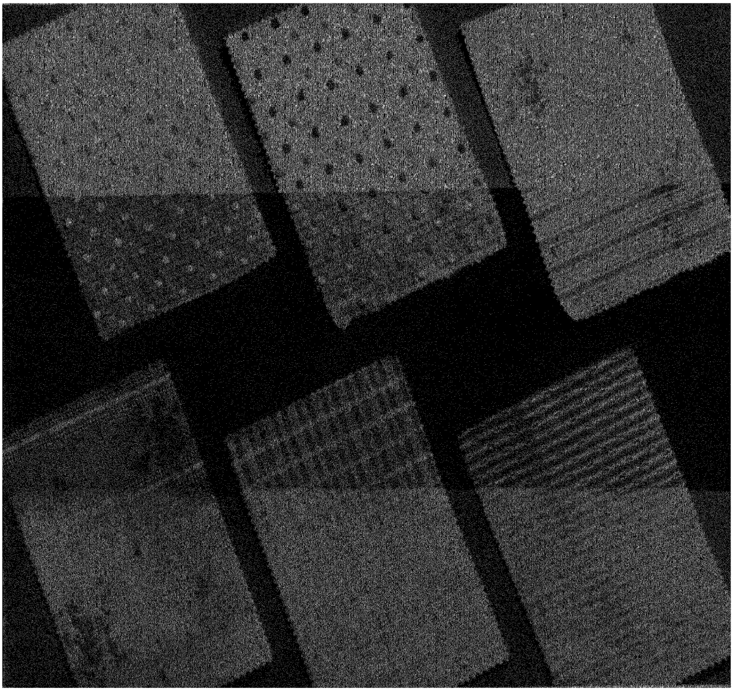


PLATE 13

All the materials shown on this page are examples of "Robia" voile, which is an all-cotton sheer in various fancy weaves, some piece-dyed, some colour woven. The range of design in the weaves is very large, and the material itself is an outstanding example of good modern design and technique applied to a classical cloth.

Tootal, Broadhurst, Lee Company Limited.



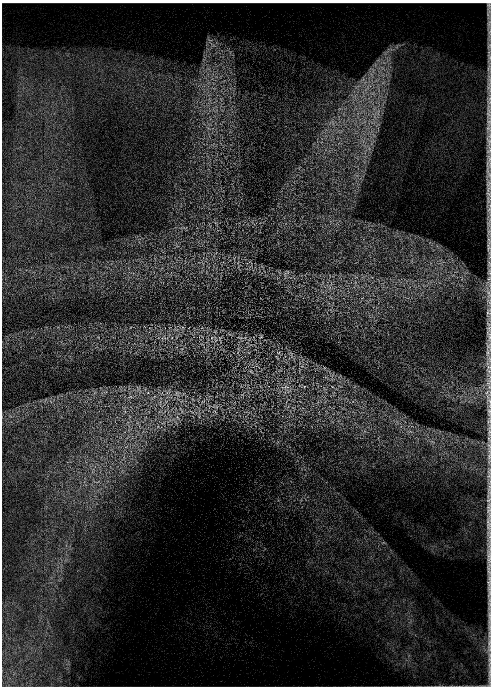


PLATE 14

Left: Crisp white organdie printed with a pale blue and white floral design.

Kiernan, Sons & Co. Ltd.

Below: Corded cotton poplin printed in pink and black and finished by special processes giving a very soft, silk-like handle.

Roosen Silks Ltd.

By courtesy of the **Cotton Board.**

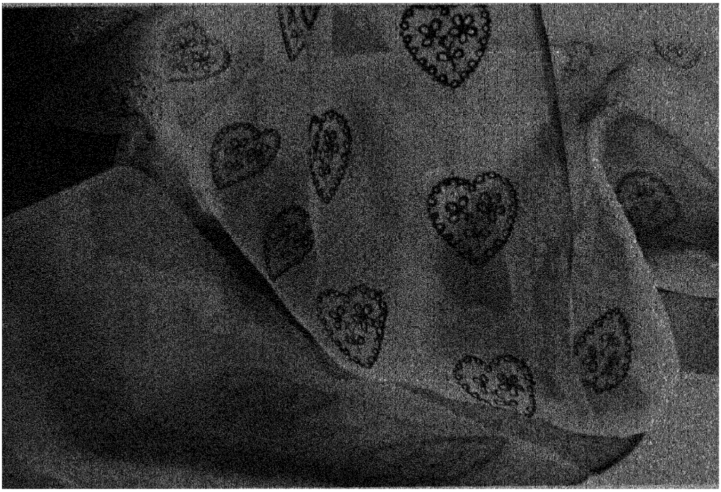


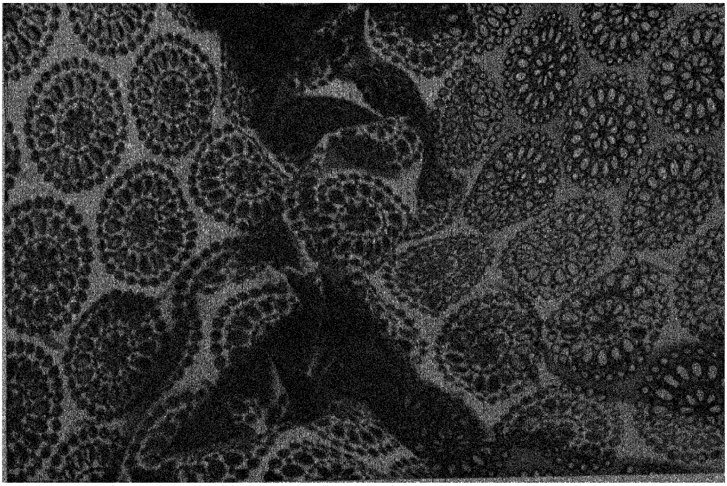
PLATE 15

Above: White organdie worked with pale blue broderie anglaise. Organdie by *Kiernan, Sons & Co. Ltd.*

Below: Royal blue broderie anglaise worked on a white cotton poplin. Cloth by *Perseverance Mill Co. Ltd.*

Broderie anglaise in both cases by *Lewis Falk Ltd.*

By courtesy of the Cotton Board.



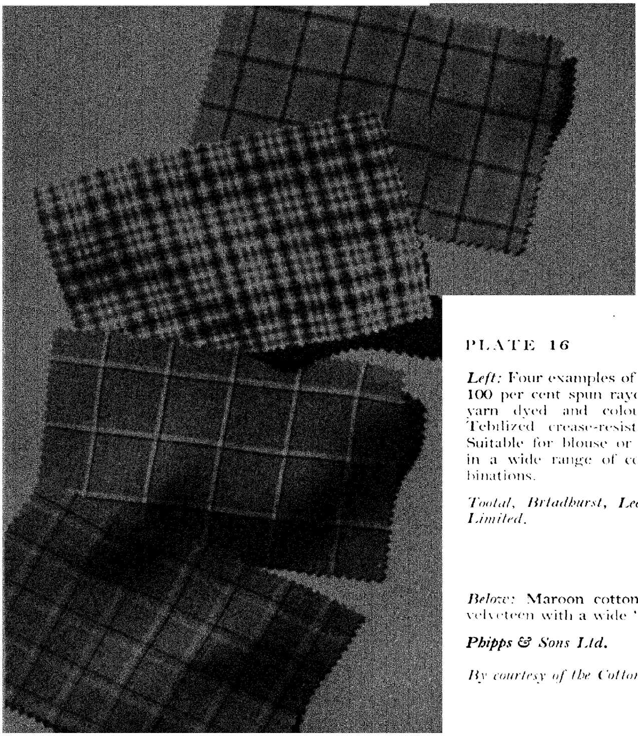


PLATE 16

Left: Four examples of "Lombia" 100 per cent spun rayon viscose, yarn dyed and colour woven, Tebilized crease-resistant finish. Suitable for blouse or dress use, in a wide range of colour combinations.

Tootal, Broadhurst, Lee Company Limited.

Below: Maroon cotton corduroy velveteen with a wide "wale."

Phipps & Sons Ltd.

By courtesy of the Cotton Board.

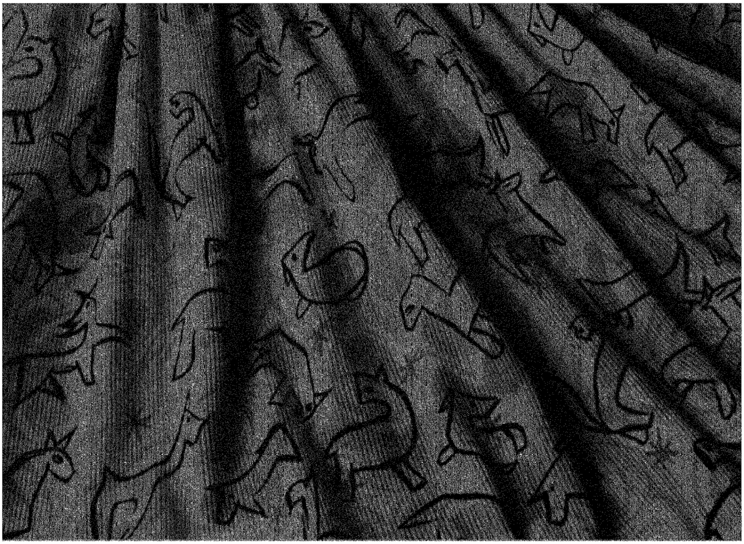


PLATE 17

Above: All-cotton white piqué printed with a small animal design in turquoise, grey, white and pink. Cloth by *Tootal, Broadhurst Lee Company Limited*, printed by *Sir T. & A. Wardle Ltd.*

Right: Mercerized cotton poplin, printed with a multi-coloured diagonal design on a red ground and finished by a special process giving a very soft, silk-like handle

Roosen Silks Ltd.

By courtesy of the Cotton Board.

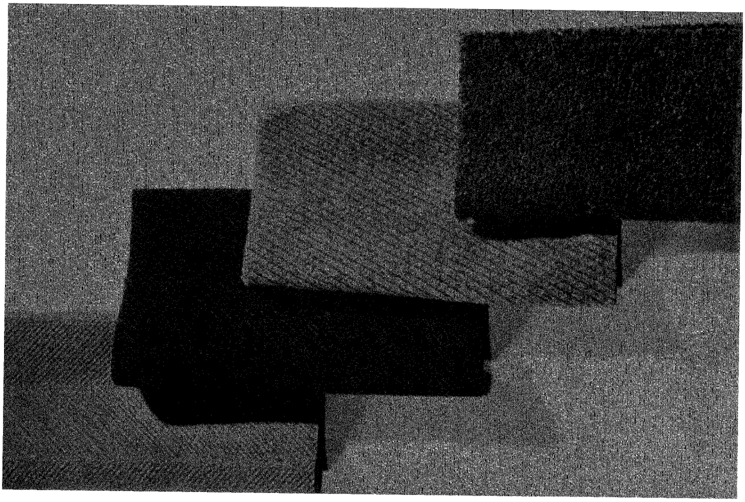
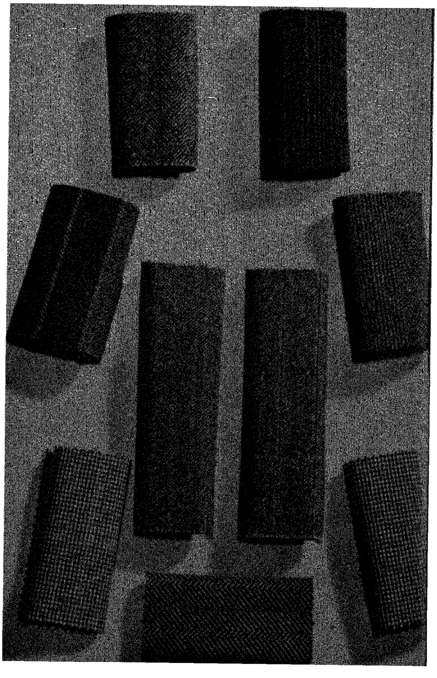


PLATE 18

Above: From right to left: Bouclé coating: heavy Saxony ladies' coating cloth with diagonal weave: 20-21 oz. Saxony ladies' coating: Saxony coating cloth with interesting treatment of diagonal ribs, in self colour.

Gibson & Lumgair Ltd

Right: Group of classical men's and women's suiting cloths. In the centre above, are two Cheviot and worsted suiting cloths by *Henry Ballantyne*: the two central examples are Saxony suitings by *Gibson & Lumgair Ltd.*, and to the left and right immediately above these are a Cheviot and worsted cloth and Cheviot and worsted suiting cloth respectively, both by *Henry Ballantyne*: below, on the left and right are two fine check worsteds by *S. H. Ravensley*, who also make the fancy corded worsted shown in the centre, below.



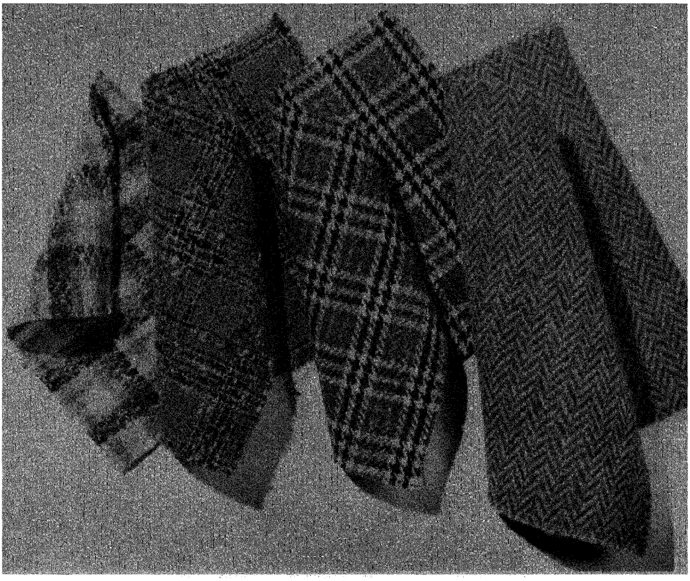
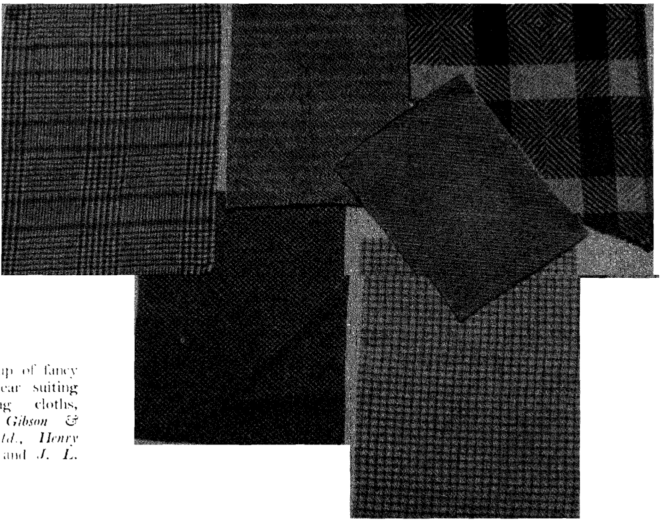


PLATE 19

Above: Four ladies' woollen-dress and coating cloths. *Gibson & Lumgair Ltd.*

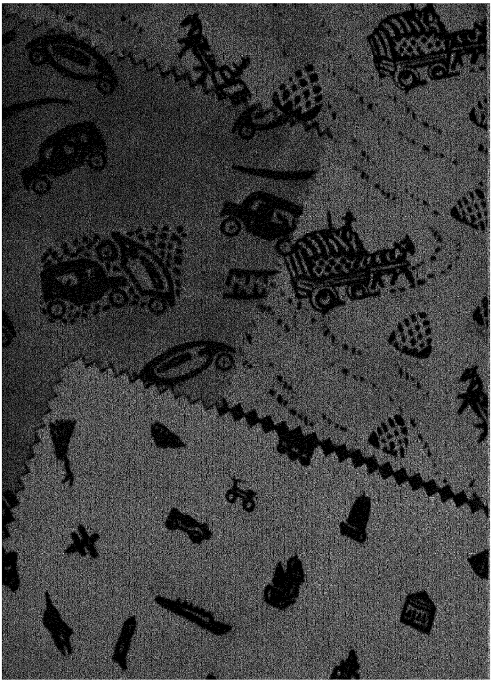


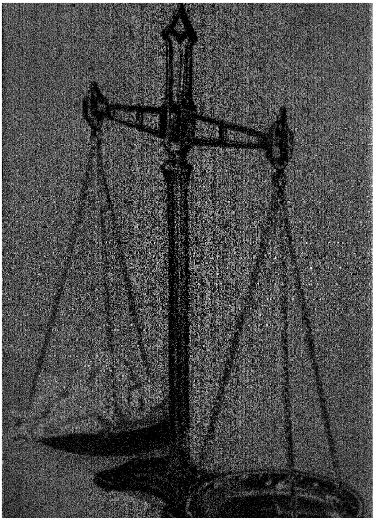
Right: Group of fancy women's wear suiting and coating cloths, made by *Gibson & Lumgair Ltd.*, *Henry Ballantyne*, and *J. L. & C. Peate*

PLATE 20

Right: Three lightweight all-wool printed dress fabrics. On the right above, a design in soft yellow and brown on a cream ground; on the left above, a pale turquoise blue ground printed in deep red; below, a deep blue print on pale cream yellow.

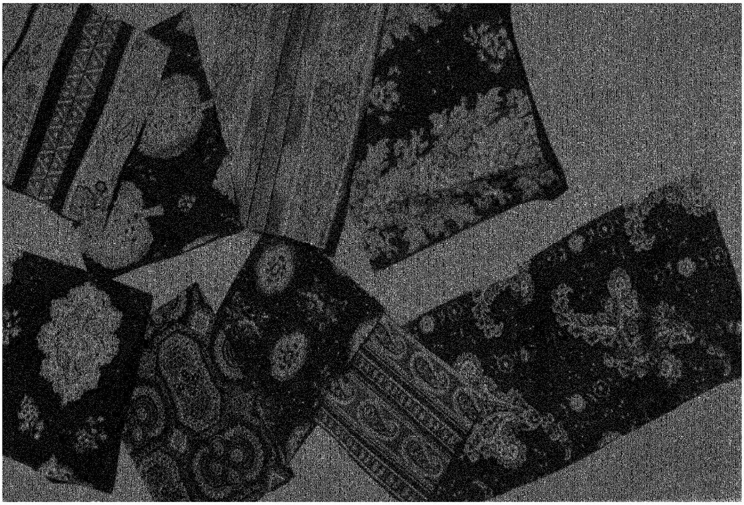
Reid & Taylor Limited.





Left: A gossamer-weight woollen fabric is shown on these scales. Woven by using a soluble seaweed yarn as carrier for the worsted, so finely spun that it could not otherwise stand up to the strain of weaving, the finishing process dissolves the seaweed carrier, leaving the lightweight material, which weighs only 1 oz. to the yard.

Silkella Ltd.



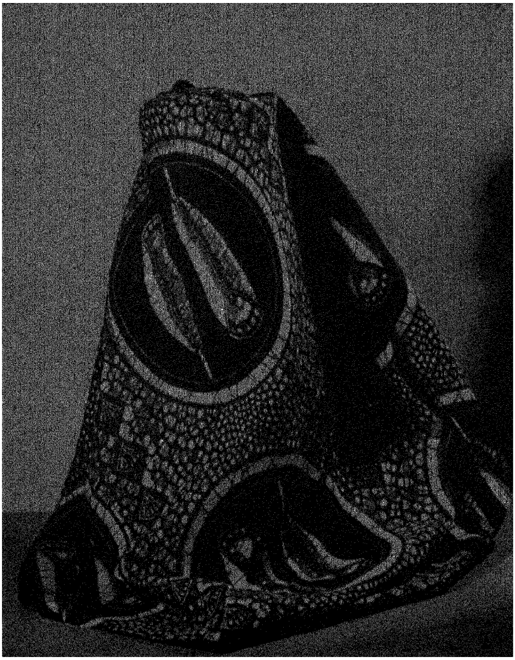


PLATE 21

Above: Group of typical designs for West African trade goods, showing the strong Paisley influence which is still popular in this market.

Right: Heavy printed cotton for the West African trade. The design shows typical development of nature forms popular with the native, produced by machine batik printing.

Calico Printers Association Limited.

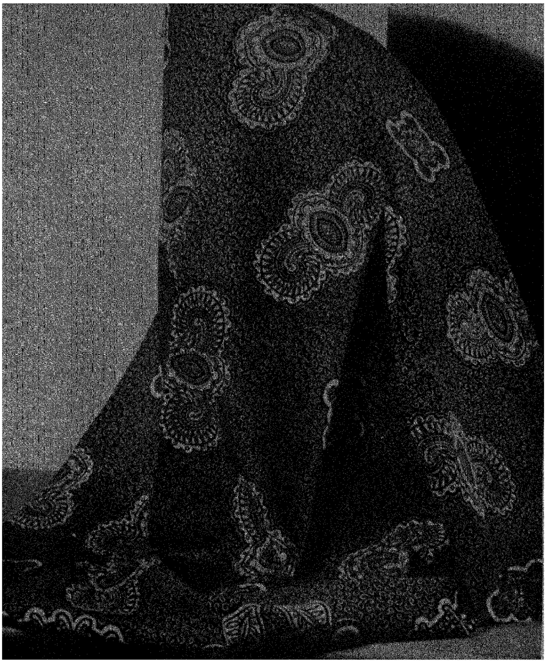
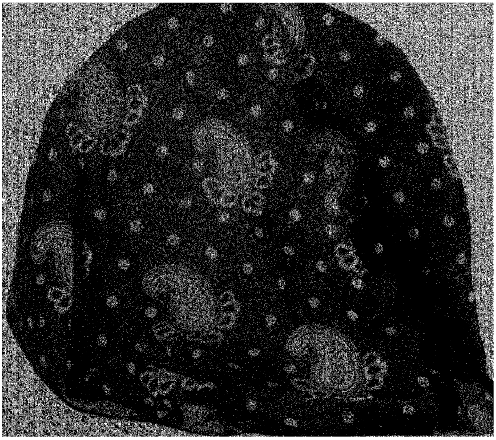


PLATE 22

Left: Printed cotton cloth for the West African trade, showing the more closely covered type of ground which is also popular in this market. Colourings here, as in all the cloths, follow the deep traditional colours which are so unchanging in this trade.

Right: Typical design with widely spaced motifs, for printed cotton West African trade goods. The main motif is bold and large in size.

Calico Printers Association Limited.



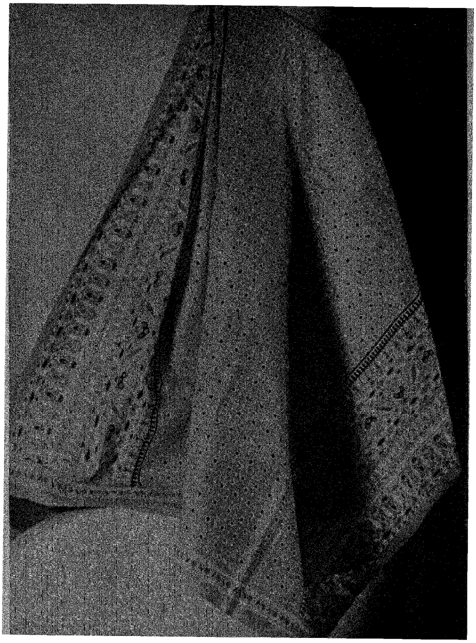


PLATE 23

Two examples of printed light quality cotton cloth produced for the East African trade. No representations of human or animal figures may appear in such designs, and colours are much sharper and more brilliant than those acceptable in West Africa. These cloths are produced in the shape of large tablecloths, and are used alternatively by the natives either as sleeping mats, garments, or tablecloths. West African goods, on the contrary, are always produced in continuous lengths, and cut as required. Note use of borders which the tablecloth form imposes on the design of these East African cloths.

Calico Printers Association Limited.

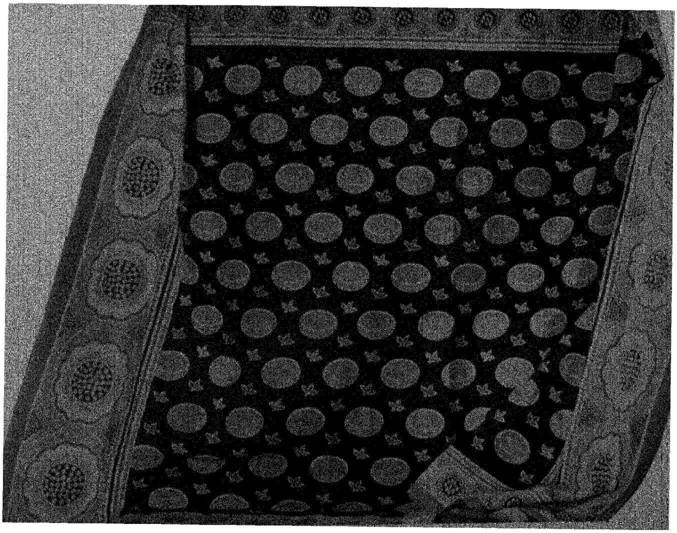
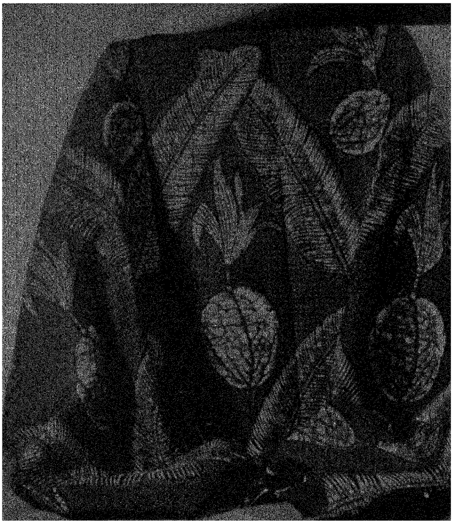
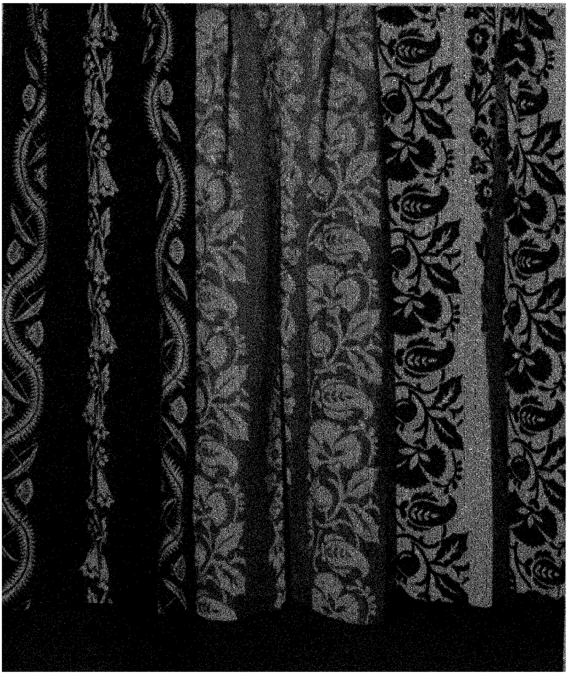


PLATE 24

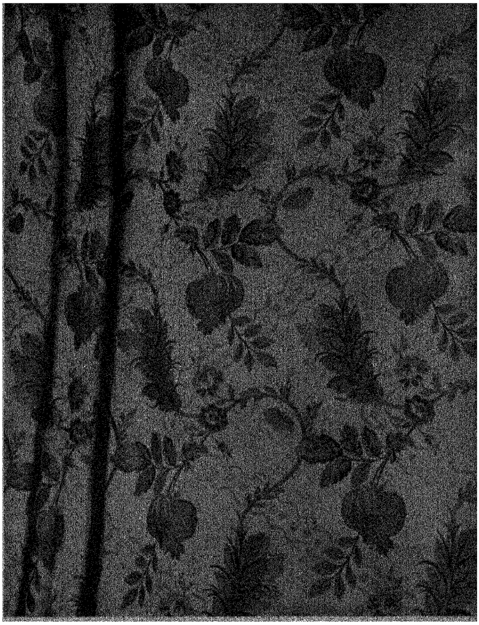
Right: Heavy printed cotton for West Africa. As in the material shown in the lower part of Plate 21, this is an example of machine batik printing.





Left: Light cotton machine printed cloth produced exclusively for the South Sea Islands, and known as pareo cloth. Designs are always bold, floral shapes generally, in white on scarlet or indigo blue grounds; alternatively, printed in the latter colours on white grounds. Some use is also made of brilliant yellow, but on the whole, scarlet and indigo blue are the two classic colours for this trade.

Calico Printers Association Limited.



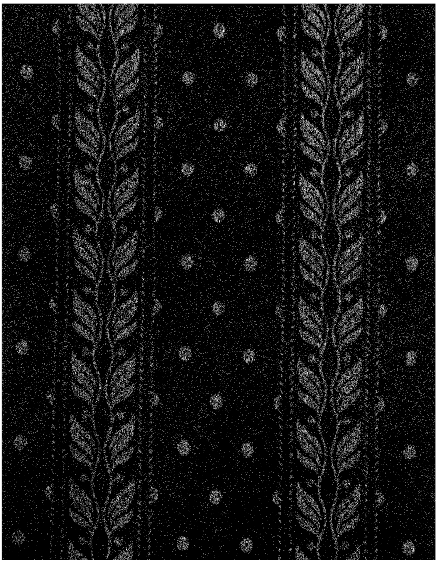


PLATE 25

Above: "Canterbury," a Jacquard figured cloth suitable for curtains or upholstery. Ivory ground and design influenced by Stuart embroidery, in multi-coloured Egyptian mercerized weft cotton. Designed by Frank Gibson.

Morton Sundour Fabrics Ltd.

Left: "Drayton," an inexpensive power-woven all-cotton damask. Deep brown ground, and paler brown design, 50 in. wide. Designed by H. Woodman.

Warner & Sons Limited.

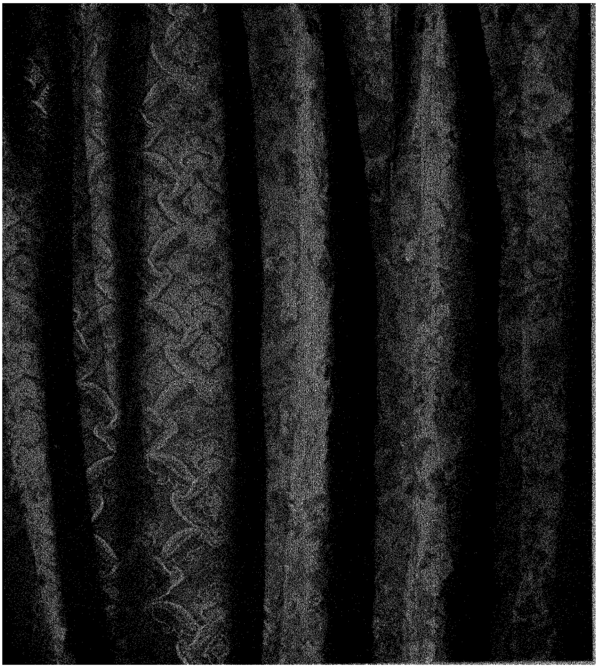
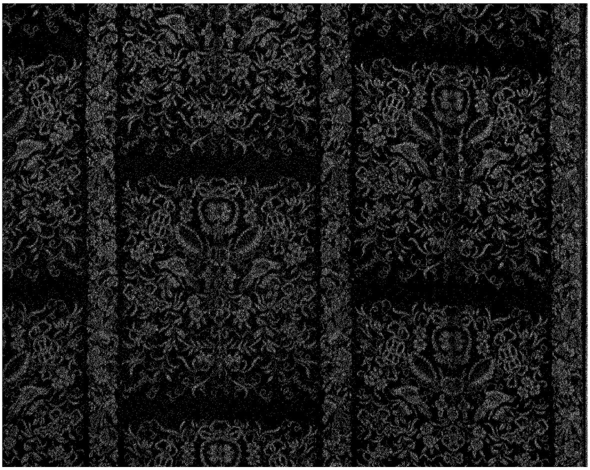


PLATE 26

Left: On the left, "Shireoaks," a cotton and rayon power-woven tissue, 50 in. wide: on the right, "Wild Vine," hand-woven all-silk brocade, in soft tones of pale blue, rose and gold; a magnificent example of the finest type of English hand-weaving, 50 in. wide. The design was adapted by Alec Hunter from an eighteenth century brocade.

Warner & Sons Limited.



Right: "Jaipur," all-rayon brocade with special quality rayon and spun rayon weft. A sumptuous material of outstanding quality and weaving technique. Design of Indo-Chinese influence, with ground colourings of deep blue, soft green, Chinese red, burgundy or lake blue.

Morton Sundour Fabrics Ltd.

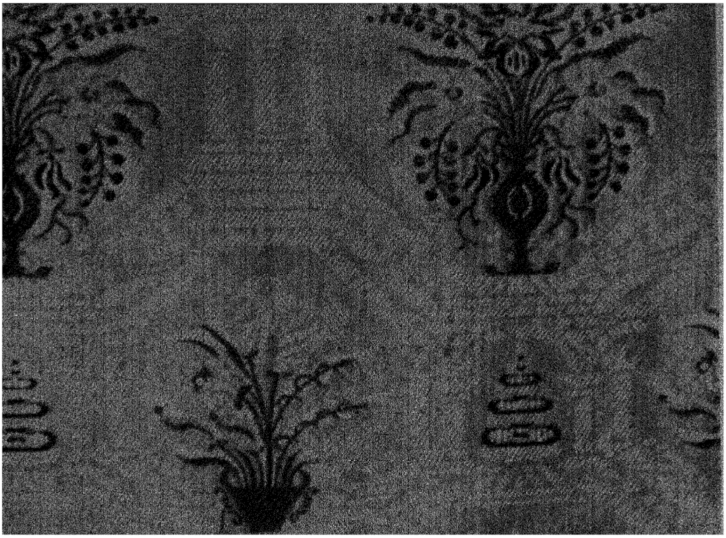


PLATE 27

Above: "Ramillies," hand-woven brocade in which a variety of fancy yarns, cotton, silk and rayon are used in the brocaded parts. 50 in. wide.

Below: "Vase," hand-woven brocade woven with the same fancy yarns as "Ramillies" design.

Both designed by Alec Hunter.

Warner & Sons Limited.

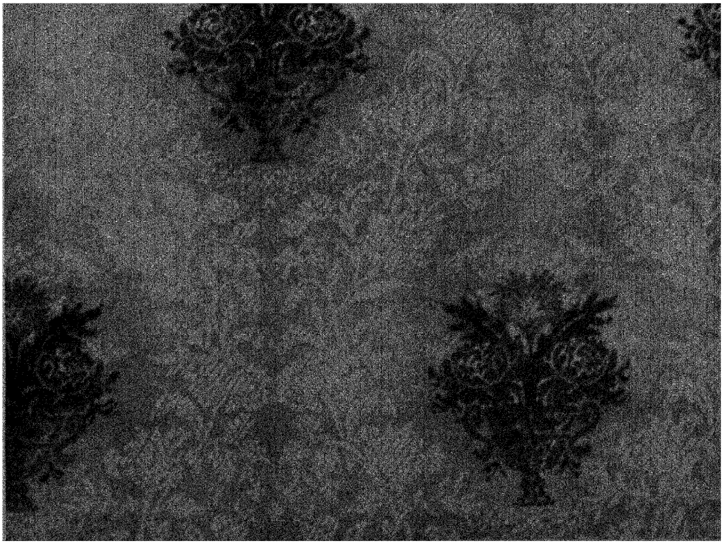
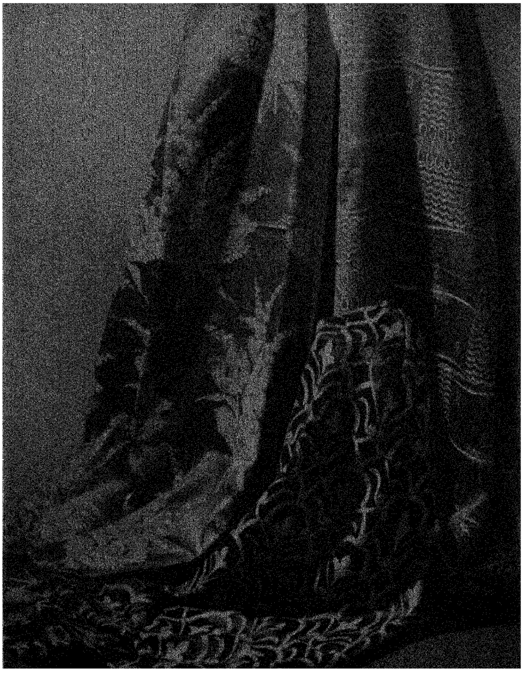


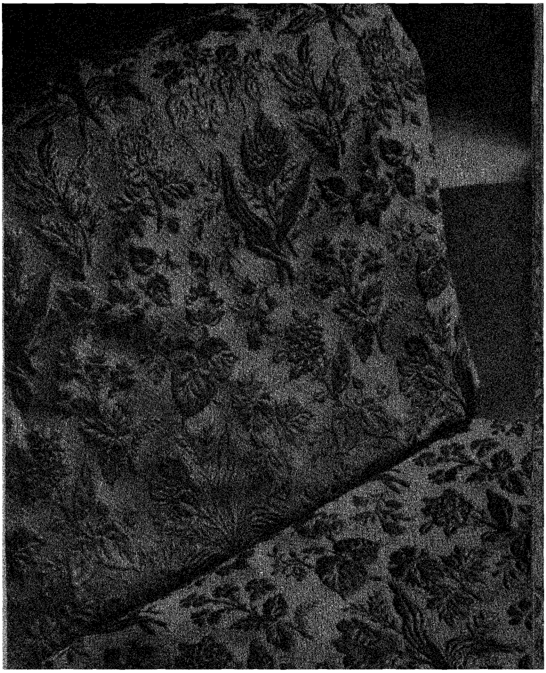
PLATE 28

Left: Fine rayon and cotton brocade, plum ground and pale gold pattern, 50 in. wide.

Below: On the left, a fine rayon and cotton brocade, deep rose ground and soft biscuit coloured pattern: in the centre, cotton and spun rayon damask with flame-coloured ground and shot pale gold and plum pattern: on the right, a fine all-cotton damask, deep rose ground and pale gold pattern: all are 50 in. wide.

Grafton Furnishing Fabrics Ltd.





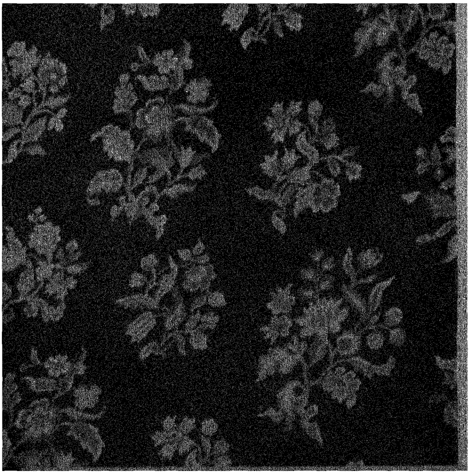


PLATE 29

Above: "Alonzo," good quality all-mercerized Egyptian cotton brocatelle for upholstery purposes. A modern variant of a classical design with units spaced to show extensive areas of interesting ground texture. In various self-coloured shades.

Left: "Chigwell," a high-class Jacquard upholstery cloth with broken ground of fine quality worsted, and cotton figuring, in ground colours of nigger, brown, wine, rust, dark blue and soft green.

Both designed by Frank Gibson

Morton Sundour Fabrics Ltd.

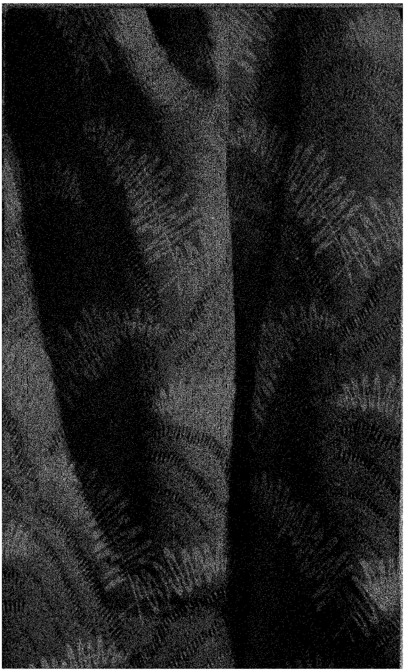


PLATE 30

Left: All-cotton tapestry in fawn and brown, 50 in. wide.

Below: All-rayon brocade in deep apple green with pattern in paler lime green, 50 in. wide.

Grafton Furnishing Fabrics Ltd.

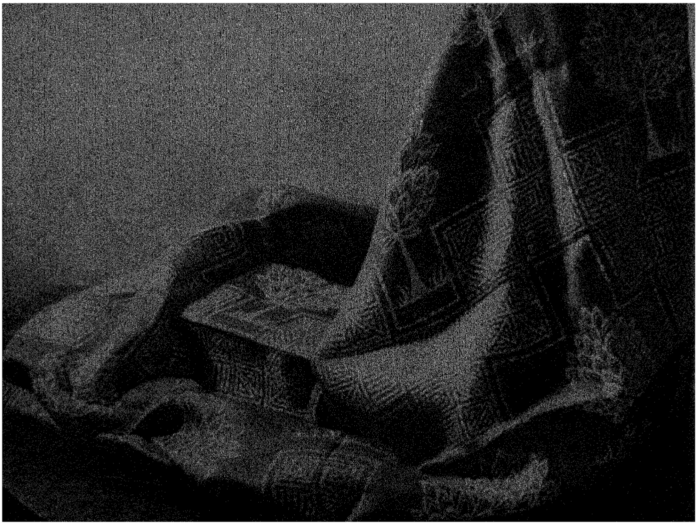
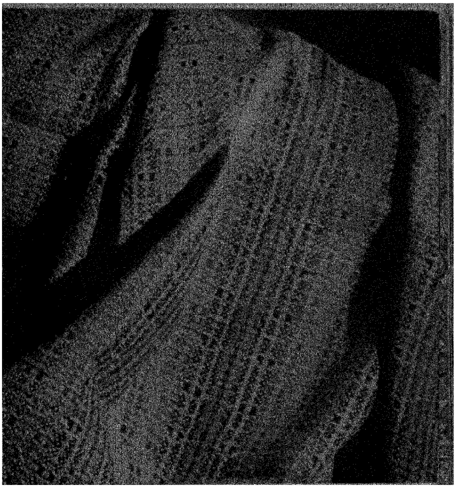


PLATE 31

Right above: "Cromarty," medium-weight cotton and rayon figured basket woven furnishing cloth, in shades of ivory, pastel blue, pink, green, gold and deep maroon. Typical modern adaptation of peasant weave. Produced in two other colour combinations, and 50 in. wide.

Right below: "Glendale," a heavy, lustrous, reversible cloth woven with horizontal stripes on one side and vertical on reverse. Ivory ground with maroon, gold, tomato, emerald, beige, blue and brown stripes. Produced in two other colour combinations, and 50 in. wide.

Donald Brothers Limited.



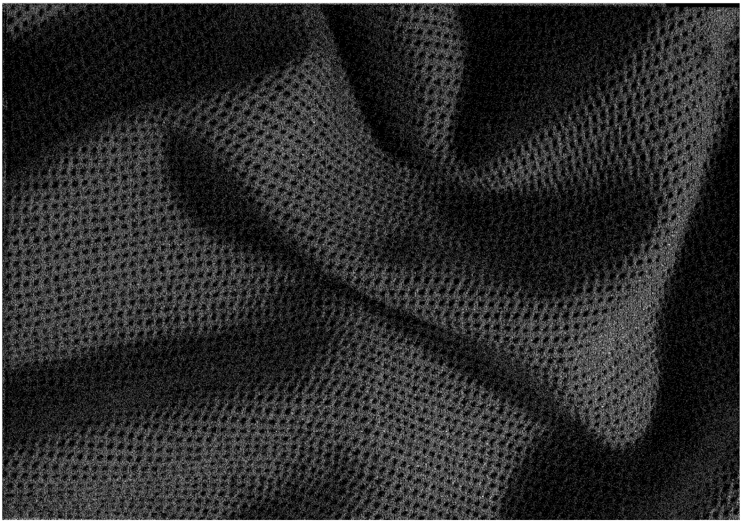


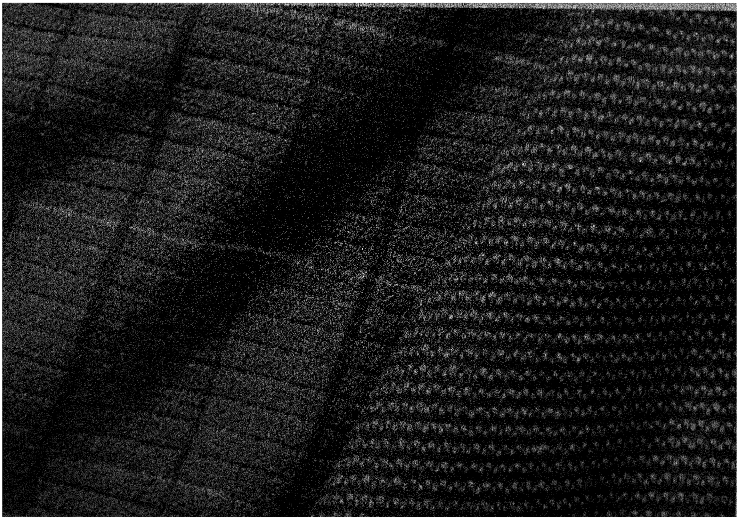
PLATE 32

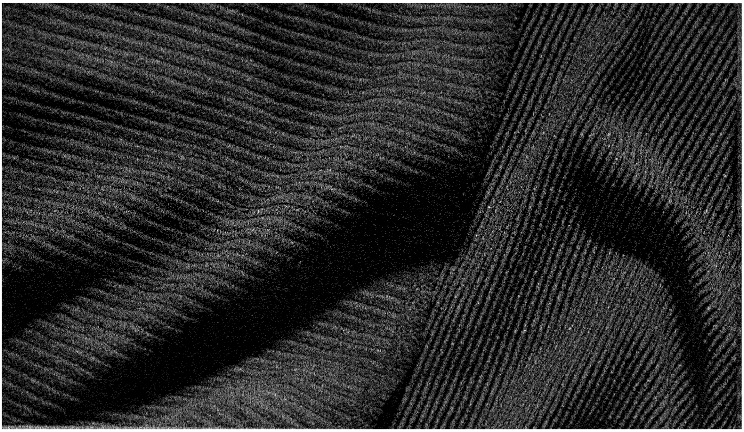
Above: Natural coloured upholstery material woven of worsted and cowhair, 50 in. wide.

Below: On the left, "Cathra," a heavy cotton upholstery material with cross bands in bright colours, 50 in. wide. On the right, "Crag," cotton and wool upholstery material, 50 in. wide.

All designed by Alastair Morton.

Edinburgh Weavers.





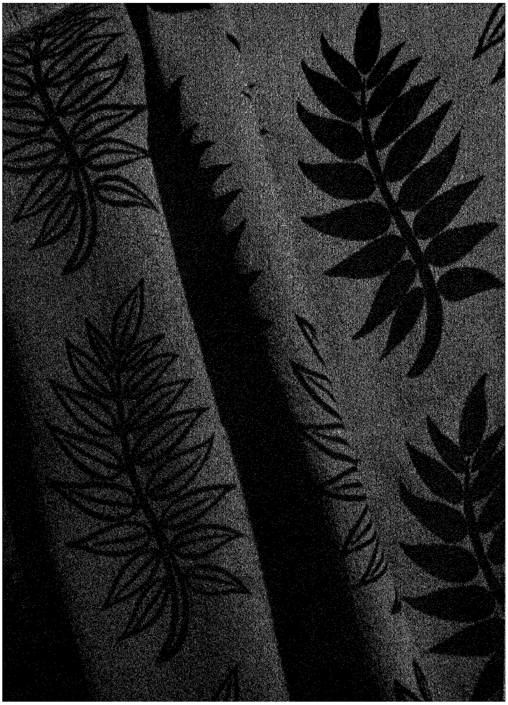


PLATE 33

Above: On the left, "Greta," heavy ribbed cotton and rayon upholstery cloth: on the right, "Sorn," heavy pile cotton fabric, 50 in. wide. Both designed by Alastair Morton.

Edinburgh Weavers.

Right: "Taynault," heavy canvas woven crash with mixed beige and natural ground screen printed in dark brown. Produced in three other colours. 50 in. wide

Donald Brothers Limited.

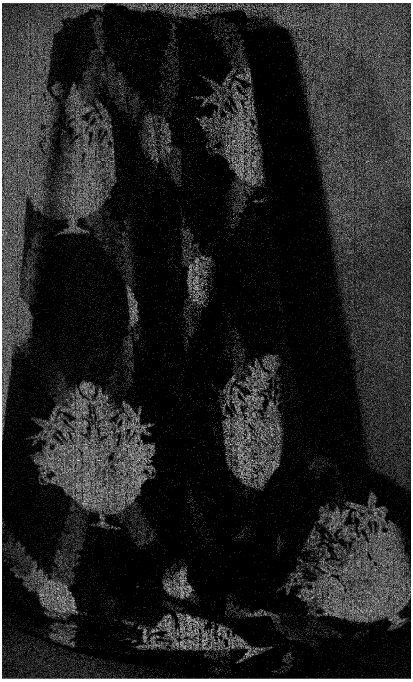


PLATE 34

Left: "Melville," all-cotton unglazed chintz, machine printed on dark blue ground in pale blue, fawn, brown and ivory. Produced in other colour combinations, 50 in. wide. Designed by Joseph M. Doran.

Warner & Sons Limited.

Right: Two modern adaptations of Chinese designs, printed by the copper roller machine method on 31 in. heavy cotton.

Rosebank Fabric by Turnbull & Stockdale Ltd.

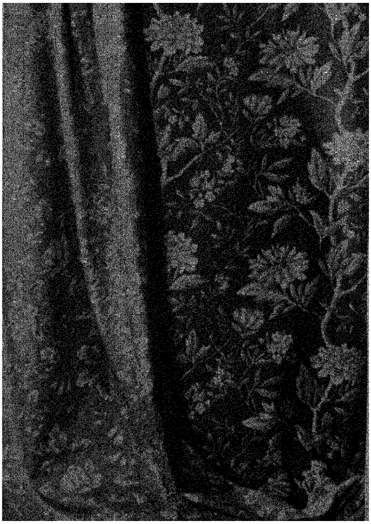
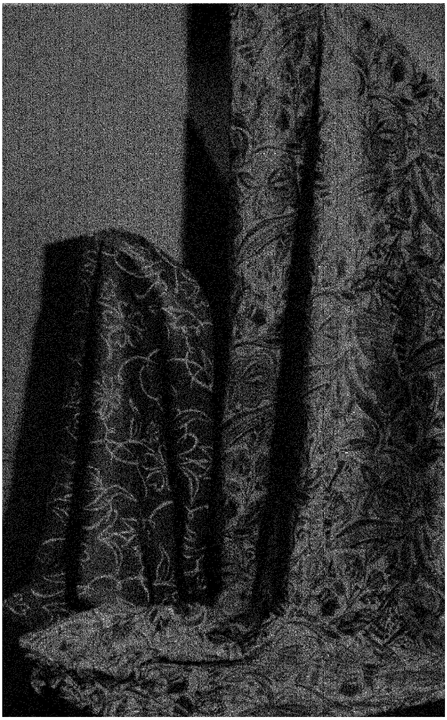


PLATE 35

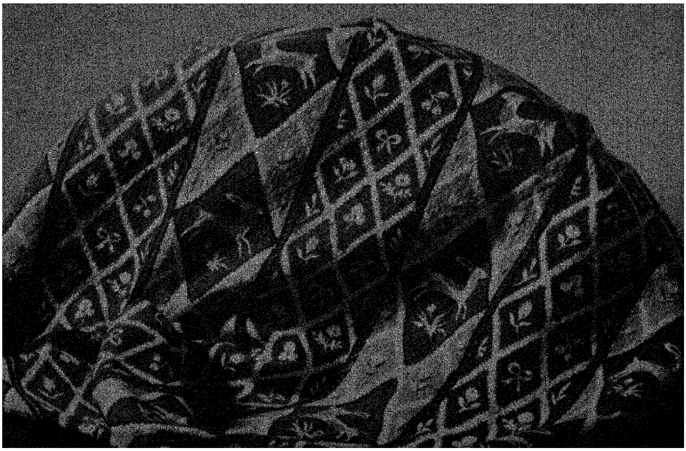
Right: On the left, a screen printed 50 in. cotton crêpe. This is a contemporary design, suitable for curtains or loose covers: on the right, a multicolour design on natural ground, hand screen printed on 50 in. linen. Designer, Hans Tisdall.

Rosebank Fabric by Turnbull & Stockdale Ltd.



Below: Heavy matelassé woven cotton, hand printed in soft tobacco brown, deep Pompeian red, fawn, emerald and white, 50 in. wide.

Grafton Furnishing Fabrics Ltd.



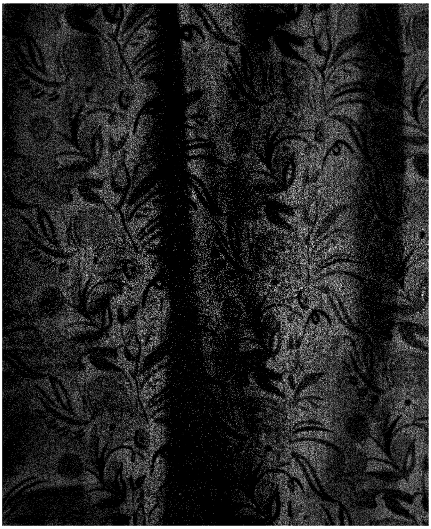
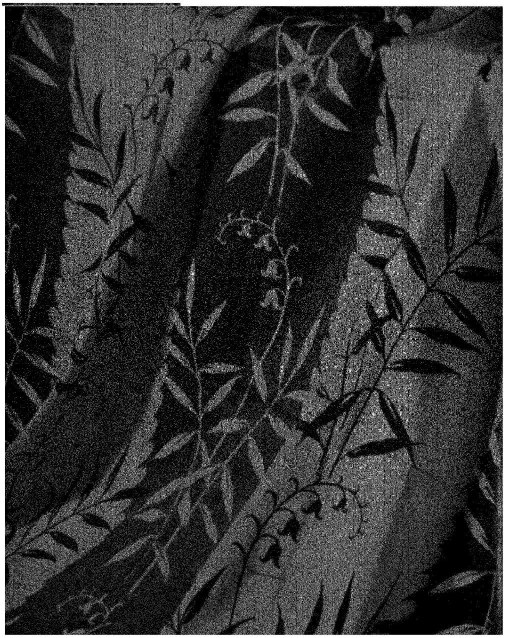


PLATE 36

Left: "Glencairn," natural string coloured crash, screen printed in terracotta, deep rose, gold, black, fawn, burnt orange and dull green. Produced in other colourings, 50 in. wide.

Donald Brothers Limited.



Right: Heavy, all-cotton Venetian satin in alternate stripes of deep viridian green and pale turquoise blue; leaves falling on the green are white and those on the blue in deep reddish brown; 50 in. wide.

Grafton Furnishing Fabrics Ltd.

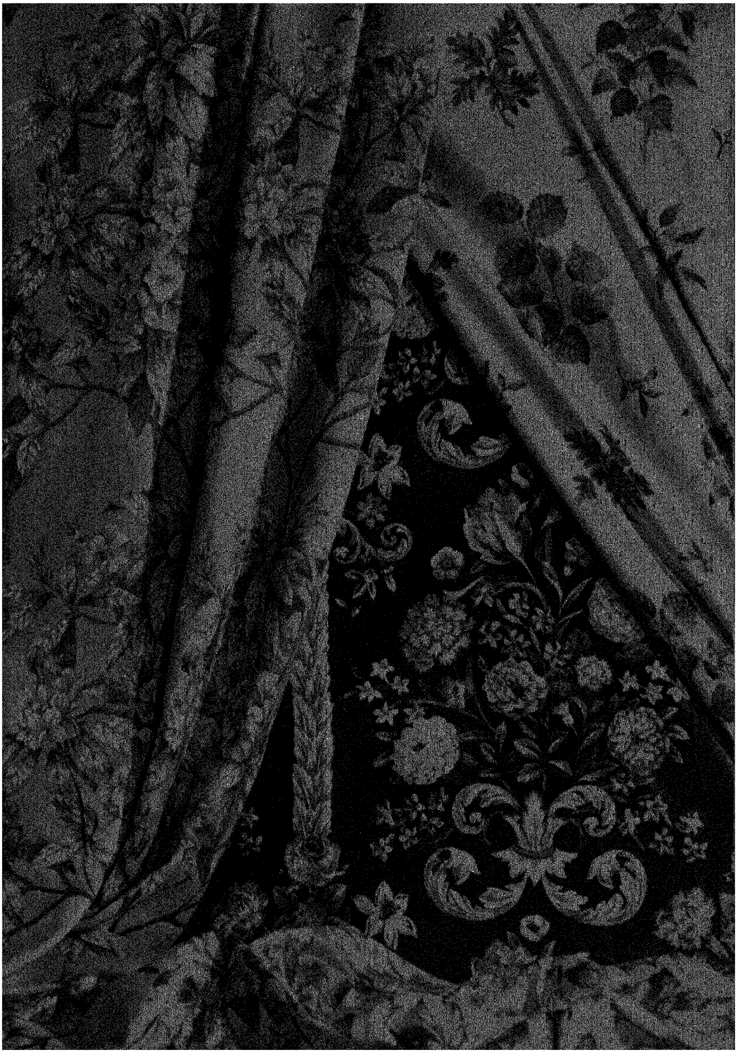


PLATE 37

Left: Machine printed glazed chintz with floral design in pale brown and pale tan on cream ground. Also produced in pale brown and green on cream ground: 31 in. wide.

Centre: "Nassau": William and Mary period design, screen printed and produced either on glazed chintz or heavy linen furnishing material. Dark brown ground with flowers in deep pink, blue, orange, yellow and fawn: also produced in other colour combinations.

Right: Heavy satin cloth screen printed in tones of peach on a cream ground: also produced in other background colours, both dark and light. This design is also printed on heavy furnishing linen: 50 in. wide.

Ramm, Son & Crocker Ltd.

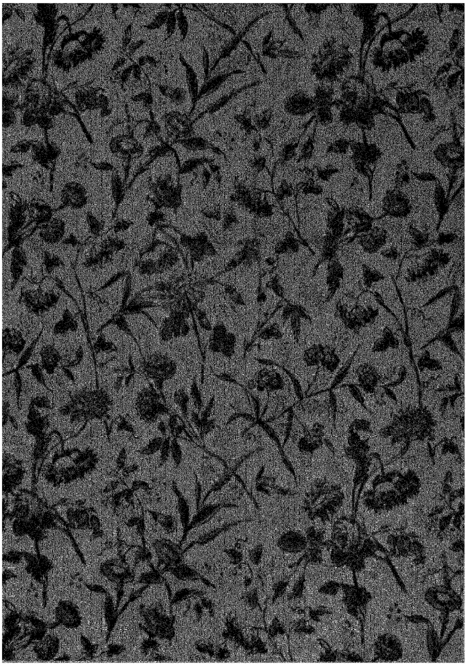
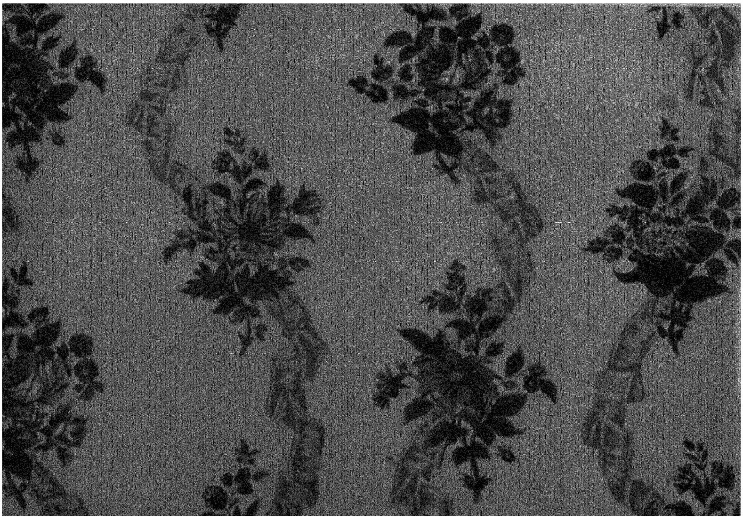


PLATE 38

Left: Small, multi-colour design, printed on white ground, from the original wooden blocks made about 1821.

Below: Glazed cotton chintz, hand block printed. The original blocks, first produced about 1835, are still used for printing this material.

Stead, McAlpin & Co. Ltd.



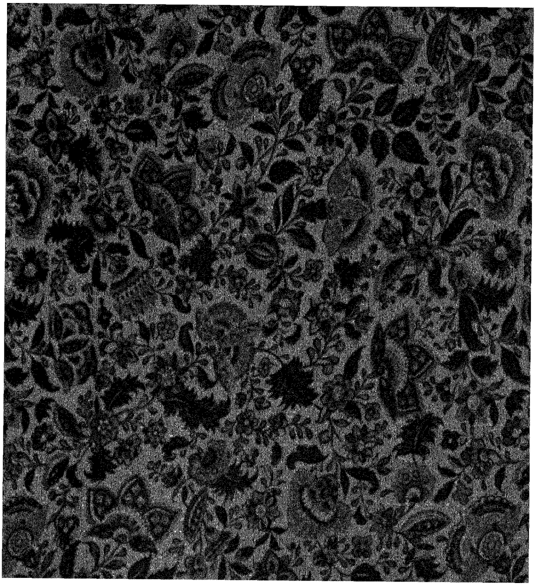


PLATE 39

Left: 100 per cent spun rayon material suitable either for dress or furnishing use, and hand printed from the original wooden blocks made in 1814 for printing chintz and dimity.

Below: Hand block printed glazed cotton chintz. This material is still printed to-day with the original wooden blocks which were made about 1825.

Stead, McAlpin & Co. Ltd.

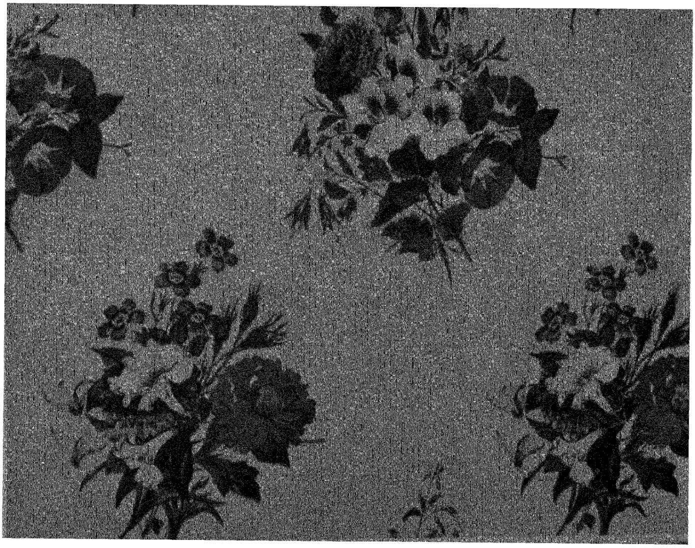
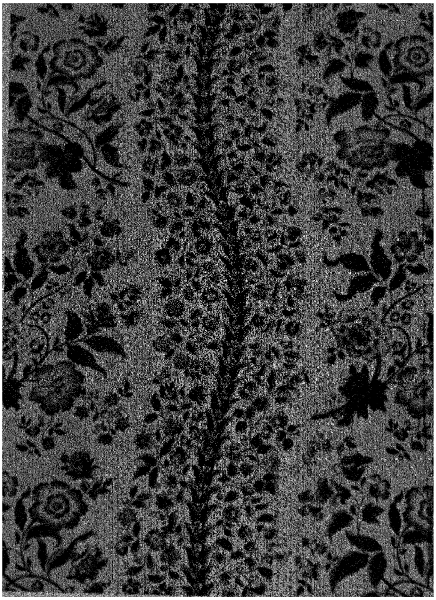


PLATE 40

Right: Heavy cotton cloth hand block printed with the same wooden blocks which were originally produced about 1815. The bold, all-over floral design shows a marked Indian influence.

Stead, McAlpin & Co. Ltd.

The wooden blocks referred to in this illustration, and in Plates 38 and 39, were originally planned for the old English chintz width of 24 in., but are so constructed that they will also print a 48 in. width material, which is a more usual width for this type of material to-day.



Left: "Kelmscott," dusty pink crash, screen printed in deep terracotta, linden green, white and grey: produced in four other colour combinations, 50 in. wide.

Donald Brothers Limited.

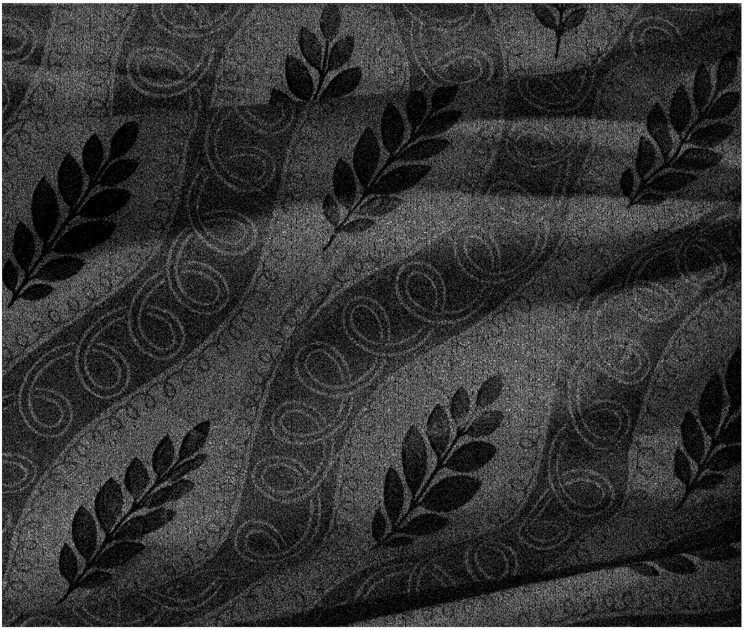


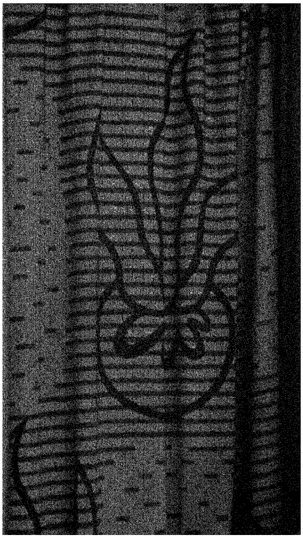
PLATE 43

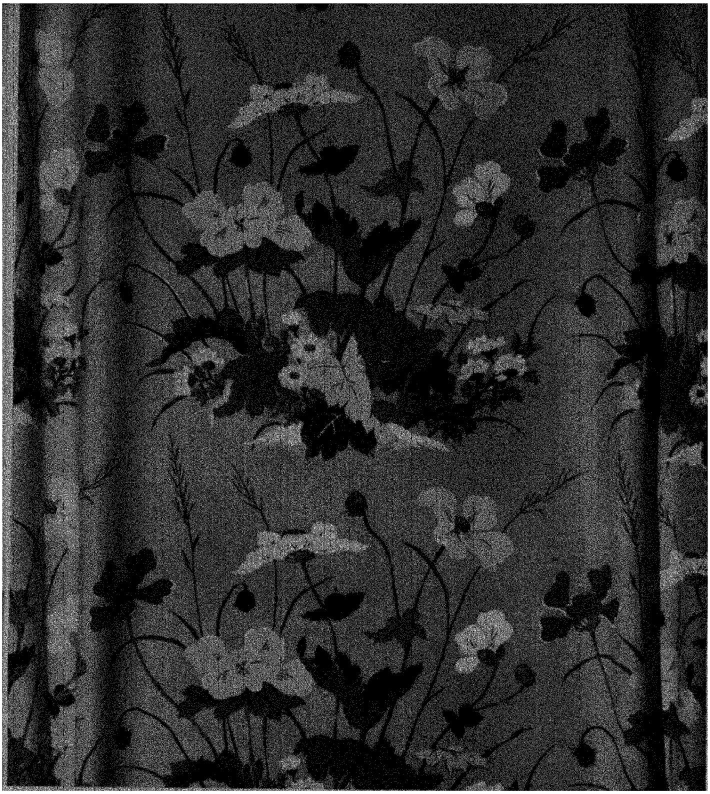
Above: "Kingley," glazed chintz, screen printed on an ivory ground with design in soft rose pink and deep green, 50 in. wide: also produced in fawn and coral and coral and yellow. Designed by H. Woodman.

Warner & Sons Limited.

Right: Cotton and rayon tuffle with white ground, screen printed in flame colour and grey, 50 in. wide. Designed by John Tandy.

Edinburgh Weavers.





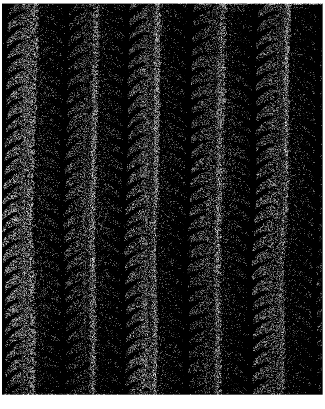


PLATE 44

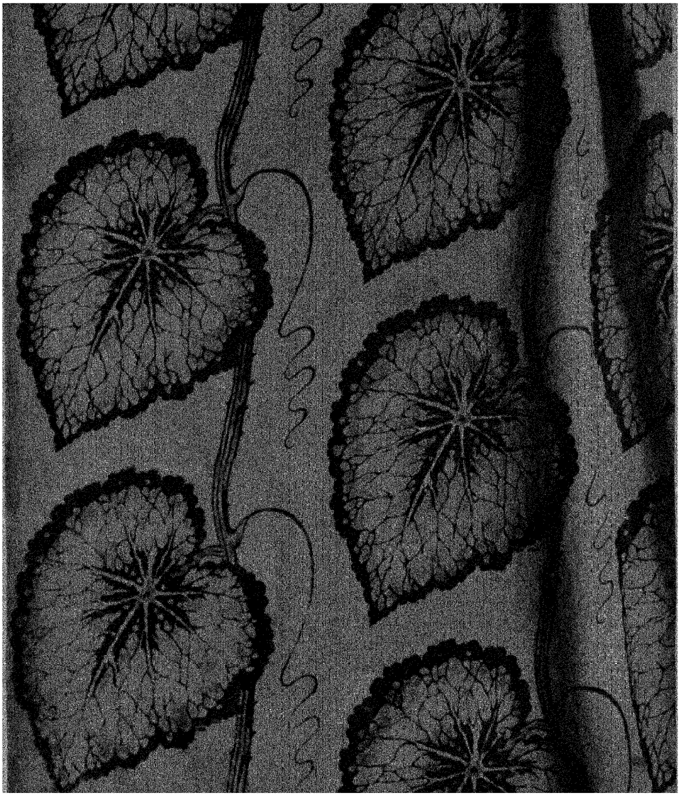
Above: Modern flat treatment of floral group printed on a soft rayon fabric, designed by Frank Gibson.

Morton Sundour Fabrics Ltd.

Left: Heavy spun rayon and cotton Roman satin, screen printed with a bold stripe design in green, brown, yellow, scarlet, black and white, 50 in. wide.

James Sterling Ltd.

By courtesy of the Cotton Board.



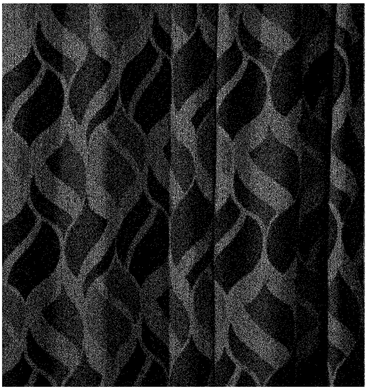
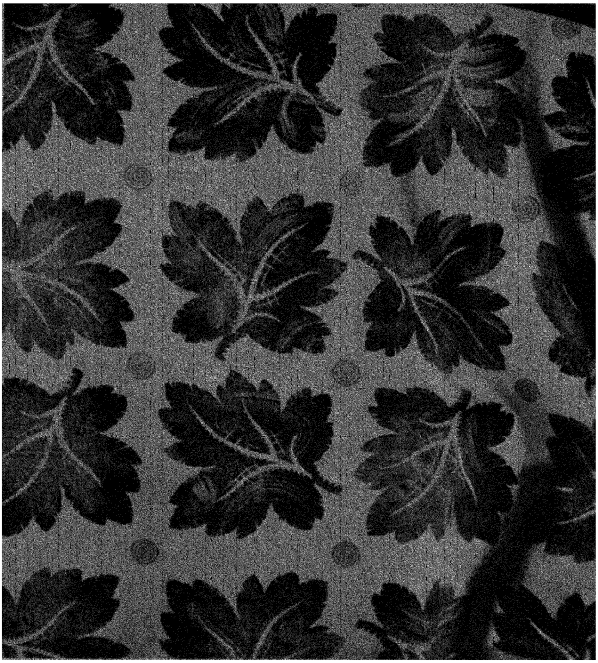


PLATE 45

Above: Leaf and stem design, screen printed on coarse linen, designed by Frank Gibson.

Morton Sundour Fabrics Ltd.

Right: "Pegtop," heavy cotton with a woven stripe, screen printed in a two-colour design. Fabric and design made for *Edinburgh Weavers* by Alastair Morton.



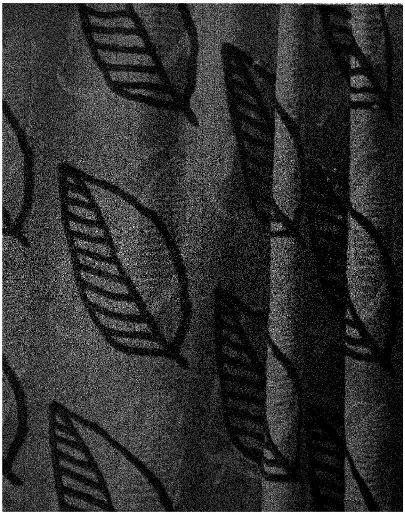


PLATE 46

Above: Symmetrical leaf and whirl design, screen printed on linen, designed by Frank Gibson.

Morton Sundour Fabrics Ltd.

Left: "Hasta," linen Jacquard curtain material, with rayon and cotton tufting. Note interest given to the design by repetition in the tufting of the leaf forms on the woven ground. 50 in. wide. Designed for *Edinburgh Weavers* by Marion Dorn and Alastair Morton.

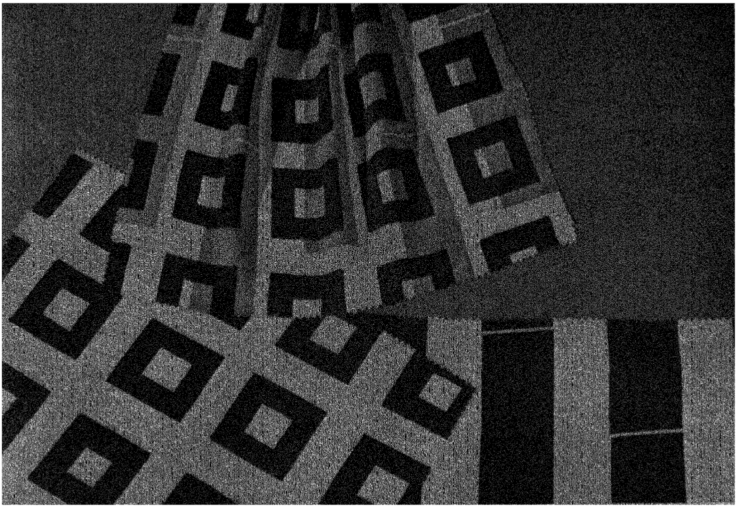


PLATE 47

Above: Two-colour printed design on light spun rayon, developed from the combination of the two single-colour designs shown. This application of the use of combined basic prints is described below. *Below:* Group of single-colour basic prints. Each can be used as a single-colour design or combined with each other as two- and three-colour prints. The material is a plain-weave light spun rayon. Colours include pastels, brilliant and dark shades, 36 in. and 50 in. wide. Designed by Alastair Morton. See Plate III facing page 96.

Edinburgh Weavers.

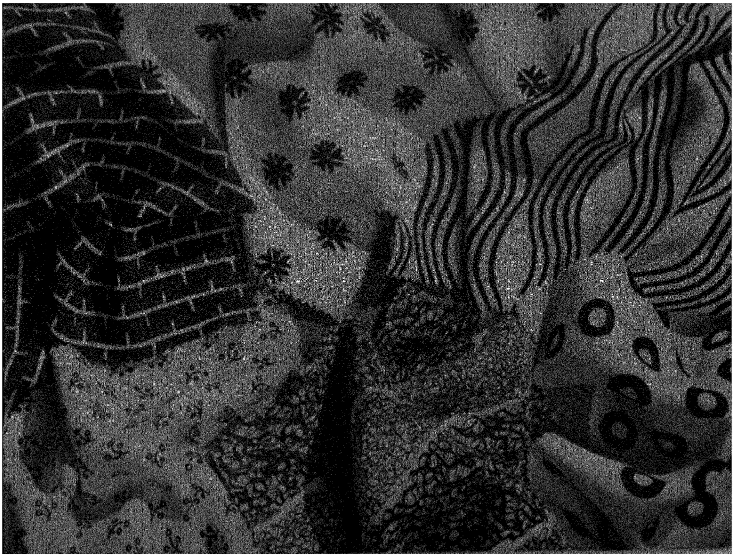
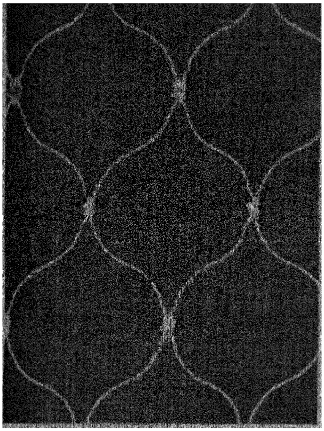
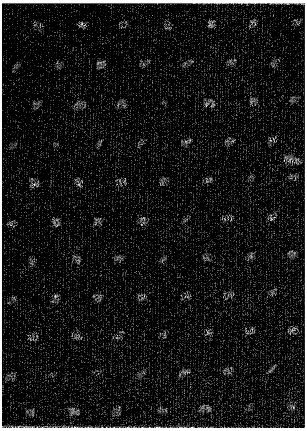


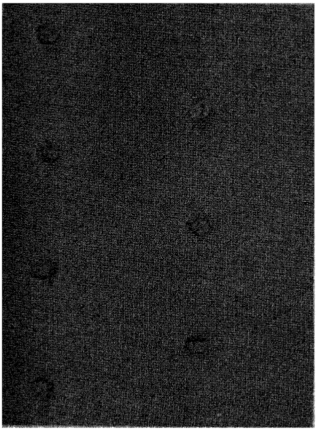
PLATE 48



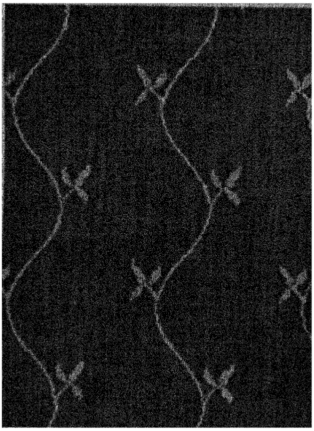
Above: Furnishing voile with embroidered arabesque design in self colour.



Above: Medium weight meshed furnishing net with woven spot. Coloured spots on cream ground, or white spots on biscuit ground.



Above: Medium furnishing mesh net, with large woven spots. On cream ground with coloured spots, or on pastel colour grounds with white spots.



Above: Furnishing voile with embroidered floral trail in self colour.

All these materials are 50 in. wide.

Morton Sundour Fabrics Ltd.